

**Technical and Professional  
Education**

**Curriculum Content Frameworks for  
Pre-Engineering**

**Curriculum Content Frameworks for  
Pre-Engineering  
Developed by the  
Department of Workforce Education**

**State of Arkansas  
Department of Workforce Education**

## **NOTICE TO THE READER**

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## **Preface**

The Technical & Professional Education program continues to prepare students for employment and continuing education. To accomplish this preparation, teachers and employers have collaborated to modify individual programs to ensure that instruction is current and comprehensive. This document reflects essential competencies for program completers as well as all aspects of the Engineering and Engineering Technology industry as required by the Carl D. Perkins Act. The Curriculum Content Frameworks for all Technical & Professional Education programs can be accessed through the Department of Workforce Education Web site.

## Foreword

The curriculum content framework Pre-Engineering supports the course that prepares students for the following career roles, which in turn correspond to the CIP (Classification of Instructional Programs) codes listed below. The courses may be sequenced with a variety of career and technical courses to form a specialization to prepare students for careers and support additional education and training in the Engineering and Engineering Technology fields.

- Career Family: Architecture and Engineering
- Career Area: Architecture and Civil Engineering
- Career Role CIP Code: 04.0801 Architects
  - 14.0901 Architectural Drafters
  - 14.0801 Civil Engineers
  - 15.0201 Civil Engineering Technicians
- O-NET: 17-1011.00 Architects
  - 17-3011.01 Architectural Drafters
  - 17-2051.00 Civil Engineers
  - 17.3022.00 Civil Engineering Technicians
- Career Area: Industrial and Mechanical Engineering
- Career Role CIP Code: 14.3501 Industrial Engineers
  - 15.0612 Industrial Engineering Technicians
  - 14.1901 Mechanical Engineers
  - 15.0805 Mechanical Engineering Technicians
- O-NET: 17-2112.00 Industrial Engineers
  - 17-3026.00 Industrial Engineering Technicians
  - 17-2141.00 Mechanical Engineers
  - 17-3027.00 Mechanical Engineering Technicians

## **Acknowledgments**

The Pre-Engineering curriculum content framework was produced by a team of program developers from the University of Arkansas at Little Rock and representatives from industry and education. A panel of experts in the field of Engineering and Engineering Technology reviewed the framework. The format and content of the framework reflect the specific training needs within the state of Arkansas. The framework content and format are modeled after a document originally developed by a writing team under the auspices of the Virginia Department of Education. Grateful appreciation is expressed to the Virginia Department of Education for granting the Arkansas Department of Workforce Education access to its instructional frameworks.

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# **Introduction**

## **About the Program**

Pre-Engineering prepares students for careers in the Engineering and Engineering Technology industry. The course sequence focuses on duties and tasks performed by professionals in Engineering and Engineering Technology as well as pre-employment and employment skills.

## **About the Document**

- Section 1 contains a master duty/task list for the Pre-Engineering program.
- Section 2 contains an analysis of each task, consisting of the task, task definition, and process/skill questions to evaluate acceptable performance. All tasks have been designated essential. Essential tasks are those that must be achieved by every student pursuing the completion of the Pre-Engineering program.
- Section 3 lists the Arkansas Standards of Learning for language arts, mathematics, and science that are reinforced by instruction in the Pre-Engineering program. Academic skills in these areas are necessary for the mastery of a number of tasks performed by engineers and engineering technicians on the job.

## **Course Descriptions**

495440 Civil Engineering and Architecture  
495450 Computer Integrated Manufacturing  
495460 Digital Electronics  
495480 Introduction to Engineering Design  
495470 Engineering Design and Development  
495490 Principles of Engineering

The Pre-Engineering program helps students understand the field of engineering and engineering technology by exploring various technology systems and manufacturing processes. Students learn how engineers and technicians use math, science, and technology in an engineering problem-solving process. The course also includes concerns about social and political consequences of technological change. Students learn about engineering design, application of electronic circuits and devices and applied logic, solid modeling software, problem-solving skills, principles of robotics and automation, an overview of the fields of Civil Engineering and Architecture, teamwork, research, and design. Students apply principles developed in the courses and are guided by community mentors. Students present progress reports, submit a final written report, and defend their solutions to a panel of outside reviewers at the end of the school year.

**Master Duty/Tasks Listing**  
**Pre-Engineering**  
 Introduction to Engineering Design  
 Digital Electronics  
 Principles of Engineering  
 Computer Integrated Manufacturing  
 Civil Engineering and Architecture  
 Engineering Design and Development

National and state experts in the occupational field of Engineering and Engineering Technology have validated the duties and tasks in this section. Each is analyzed by identifying the following:

- a *duty/task statement*, which describes what the student is to do

**Duty/Task Statements**  
**Introduction to Engineering Design**

<b>DUTY A:</b> <b>Overview of Engineering Design</b>
<b>Task:</b>
A 010: The history of design
A 020: Professional organizations
A 030: Career opportunities
A 040: Education requirements
<b>DUTY B:</b> <b>Introduction to Design</b>
<b>Task:</b>
B 010: The design process
B 020: Principles and elements of design
<b>DUTY C:</b> <b>Student Portfolio Development</b>
<b>Task:</b>
C 010: Developing a student portfolio
<b>DUTY D:</b> <b>Sketching and Visualization</b>
<b>Task:</b>
D 010: Sketching techniques

D 020: Pictorial sketching
D 030: Annotated sketches
<b>DUTY E: Geometric Relationships</b>
<b>Task:</b>
E 010: Geometric forms and shapes
E 020: Geometric constraints
E 030: Coordinate systems
<b>DUTY F: Modeling</b>
<b>Task:</b>
F 010: Conceptual modeling
F 020: Graphical modeling
F 030: Physical modeling
F 040: Mathematical modeling
F 050: Computer modeling
<b>DUTY G: Assembly Modeling</b>
<b>Task:</b>
G 010: Adding modeling components
G 020: Assembly modeling constraints
G 030: Part library
G 040: Sub-assemblies
G 050: Drive constraints and motion simulation
G 060: Adaptive design
<b>DUTY H: Modeling Analysis and Verification</b>
<b>Task:</b>

H 010: Mass properties
H 020: Tolerancing
<b>DUTY I: Model Documentation</b>
<b>Task:</b>
I 010: Working drawings
I 020: Dimensioning
I 030: Drawing notes
<b>DUTY J: Presentation</b>
<b>Task:</b>
J 010: Communication techniques
J 020: Presentation techniques
<b>DUTY K: Production</b>
<b>Task:</b>
K 010: Manufacturing design analysis
K 020: Process planning
K 030: Design for automated manufacturing
K 040: Materials, procurement, handling, and cost analysis
K 050: Quality control
K 060: Manpower and facility requirements
K 070: Packaging
<b>DUTY L: Marketing</b>
<b>Task:</b>
L 010: Product analysis
L 020: Packaging requirements

**Duty/Task Statements**  
**Digital Electronics**

<b>DUTY A:</b>
<b>Analog and Digital Fundamentals</b>
<b>Task:</b>
A 010: Voltage, current, and resistance
A 020: Kirchhoff's Law
A 030: Introduction to digital electronics
A 040: Analog and digital waveforms
<b>DUTY B:</b>
<b>Number Systems and Binary Addition</b>
<b>Task:</b>
B 010: Counting and converting number systems
B 020: Adding and subtracting binary numbers
B 030: Encoding decimal numbers to binary format
<b>DUTY C:</b>
<b>Introduction to Logic Gates</b>
<b>Task:</b>
C 010: Logic gates
C 020: Duality of logic functions
C 030: The exclusive OR and exclusive NOR functions
<b>DUTY D:</b>
<b>Digital Logic Specifications and Families</b>
<b>Task:</b>
D 010: IC specifications
<b>DUTY E:</b>
<b>Boolean Algebra and Circuit Design</b>
<b>Task:</b>
E 010: Boolean expressions for combinational circuits
E 020: Waveform logic

E 030: Decimal to BCD encoder
E 040: Combinational logic
E 050: Practical applications of combinational logic
<b>DUTY F: Binary Adders and Subtractors</b>
<b>Task:</b>
F 010: Adder and subtractor design

**Duty/Task Statements  
Principles of Engineering**

<b>DUTY A: Overview and Perspective of Engineering</b>
<b>Task:</b>
A 010: What is engineering?
A 020: Career choices in engineering
A 030: The engineering case study
<b>DUTY B: Communications in Engineering</b>
<b>Task:</b>
B 010: Written and oral communication
B 020: Graphic representation of numerical data
B 030: Computer aided design
<b>DUTY C: The Process of Engineering</b>
<b>Task:</b>
C 010: The problem-solving method
C 020: The team approach to engineering
C 030: Engineering and engineering technology career pathways

<b>DUTY D:</b>
<b>Engineering Systems</b>
<b>Task:</b>
D 010: Mechanical mechanism systems
D 020: Electro-mechanical systems
D 030: Hydraulic systems
D 040: Pneumatic systems
D 050: Motors and generators
D 060: Control systems
<b>DUTY E:</b>
<b>The Manufacturing Process in Engineering</b>
<b>Task:</b>
E 010: Precision measurement
E 020: Quality assurance and process control
E 030: Production processes
E 040: Computer-aided manufacturing
<b>DUTY F:</b>
<b>Materials and Materials Testing in Engineering</b>
<b>Task:</b>
F 010: Categories of materials
F 020: Properties of materials
F 030: Material testing processes
F 040: Material suitability and application

**Duty/Task Statements**  
**Computer-integrated Manufacturing**

<b>DUTY A:</b>
<b>Computer Modeling</b>
<b>Task:</b>
A 010: Fundamentals of computer modeling
A 020: Object construction
A 030: Parts modeling
A 040: Creation of drawing views
A 050: Assembly modeling
A 060: Rapid prototyping
<b>DUTY B:</b>
<b>Programmable Machines</b>
<b>Task:</b>
B 010: The history of programmable machines
B 020: CNC characteristics
B 030: CNC programming
B 040: CNC operations
B 050: Precision measurement
B 060: CAM software
<b>DUTY C:</b>
<b>Introduction To Robotics</b>
<b>Task:</b>
C 010: Introduction to robotics
C 020: Robotics and automated systems
C 030: Robot characteristics
C 040: Mechanical components



C 050: Control systems
C 060: Programming methods
C 070: Industrial robot applications
<b>DUTY D: Computer-integrated Manufacturing</b>
<b>Task:</b>
D 010: Rationale for CIM
D 020: Types of CIM systems
D 030: Components of CIM systems
D 040: CIM system applications

**Duty/Task Statements  
Civil Engineering and Architecture**

<b>DUTY A: Comparison of Civil Engineering and Architecture</b>
<b>Task:</b>
A 010: Concept map of civil engineering and architecture
A 020: Civil engineering and architecture overview
<b>DUTY B: Introduction to Projects</b>
<b>Task:</b>
B 010: Overview of project design
B 020: Project documentation
<b>DUTY C: Project Planning</b>
<b>Task:</b>
C 010: Site information--Discovery
C 020: Site information--Regulations
C 030: Site information--Generic Viability Analysis

C 040: Development options and project selection
C 050: Revisiting viability analysis
<b>DUTY D: Site Planning</b>
<b>Task:</b>
D010: Site planning concepts
D 020: Description of property
D 030: Site plan requirements
D 040: Site plan layout
D 050: Public ingress/egress
D 060: Site grading
D 070: Site utility requirements
D 080: Site landscaping
<b>DUTY E: Architecture Design Process</b>
<b>Task:</b>
E 010: Architectural considerations in project design
E 020: Floor plans
E 030: Energy systems
E 040: Elevations
E 050: Sections and details
E 060: Schedules
E 070: Mechanical systems
E 080: Electrical systems
E 090: Protection systems

<b>DUTY F:</b> <b>Structural Engineering</b>
<b>Task:</b>
F 010: Structural engineering overview
F 020: Load requirements
F 030: Foundations
F 040: Columns and beams
F 050: Roof systems
<b>DUTY G:</b> <b>Presentation and Reviews</b>
<b>Task:</b>
G 010: Critiques and reviews
G 020: Final presentations

**Duty/Task Statements**  
**Engineering Design and Development**

<b>DUTY A:</b> <b>Introduction to Engineering Design and Development</b>
<b>Task:</b>
A 010: Justification of course/project
A 020: Review of expectations
<b>DUTY B:</b> <b>Elements of Formal Research</b>
<b>Task:</b>
B 010: Daily research journal
B 020: Conventional library resources
B 030: Using the computer as a research tool
B 040: Contacting the experts

<b>DUTY C:</b>
<b>Guided Research</b>
<b>Task:</b>
C 010: Methods of brainstorming
C 020: Research a topic
C 030: How to write a problem statement
C 040: Researching alternative solutions
C 050: Developing alternative solutions
C 060: Redefining and justifying alternative solutions
C 070: Presentation methods
<b>DUTY D:</b>
<b>Independent Research</b>
<b>Task:</b>
D 010: Independent research
D 020: Developing a prototype
D 030: Research paper
<b>DUTY E:</b>
<b>Formal Presentation</b>
<b>Task:</b>
E 010: Formal presentations

**Task Definitions**  
**Pre-Engineering**  
 Introduction to Engineering Design  
 Digital Electronics  
 Principles of Engineering  
 Computer Integrated Manufacturing  
 Civil Engineering and Architecture  
 Engineering Design and Development

National and state experts in the occupational field of Engineering and Engineering Technology have validated tasks in this section. Each task is analyzed by identifying the following:

- a *task definition* (criteria for acceptable performance), which explains what the student has to do to perform the task at the expected level of mastery
- *process/skill questions*, which assess student knowledge and performance

Tasks are arranged by instructional duty area only. The placement of tasks into specific courses and the sequencing of tasks for instruction are local decisions based on student needs, employer demand, and school schedules.

**Task Definitions**  
**Introduction to Engineering Design**

<b>DUTY A:</b>
<b>Overview of Engineering Design</b>
<b>Task:</b>
<p><b>A 010: The history of design</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• develop an appreciation of how the history of art has influenced innovations in the field of engineering</li> <li>• explain the impact of artistic expression as it relates to consumer products</li> <li>• research how artistic period and style have influenced product and architectural design</li> <li>• explore the design concept of form and function, and explain its use in product design</li> <li>• explore the evolution of technology, and identify engineering achievements through history</li> <li>• research the chronological development and accelerating rate of change that innovations in tools and materials have brought about over time as they relate to a given consumer product</li> <li>• review the history of measurement tools, and identify two innovations that have led to improved functionality of a measuring tool</li> </ul> <p>Process/Skill Questions</p>

### **A 020: Professional organizations**

*Definition:* Process should include the following:

- explore a given professional organization for engineering
- summarize in a short PowerPoint presentation the range of services provided by the organization

Process/Skill Questions

### **A 030: Career opportunities**

*Definition:* Process should include the following:

- identify career opportunities in design and engineering
- explain the job functions for careers in design and engineering
- identify career opportunities for engineering technicians
- explain the job functions for careers as an engineering technician

Process/Skill Questions

### **A 040: Education requirements**

*Definition:* Process should include the following:

- explore career opportunities in a given engineering field
- list the educational requirements for several professions in engineering

Process/Skill Questions

## **DUTY B: Introduction to Design**

### **Task:**

### **B 010: The design process**

*Definition:* Process should include the following:

- list the seven steps of the design process, and explain the activities that occur during each phase
- assess the value of working as a team, and understand the benefits of collaboration
- discuss the importance of focusing on detail when executing the design process
- apply the steps of the design process to solve a variety of design problems

Process/Skill Questions

**B 020: Principles and elements of design**

*Definition:* Process should include the following:

- investigate the principles and elements of design
- identify the use of the principles and elements of design in various products, print media, and art forms
- demonstrate an understanding of the principles and elements of design by incorporating them in design solutions
- collect and display examples of the application of principles and elements of design utilized in products, print media, and art forms

Process/Skill Questions

**DUTY C:****Student Portfolio Development****Task:****C 010: Developing a student portfolio**

*Definition:* Process should include the following:

- identify the proper elements of a fully developed portfolio
- identify and discuss the ethical issues surrounding portfolio artifacts
- compare and contrast defined elements of a good portfolio to the PLTW sample provided
- develop a portfolio to organize and display evidence of previous work

Process/Skill Questions

**DUTY D:****Sketching and Visualization****Task:****D 010: Sketching techniques**

*Definition:* Process should include the following:

- integrate proper sketching techniques and styles in the creation of sketches
- demonstrate the ability to sketch two-dimensional geometric figures

Process/Skill Questions

**D 020: Pictorial sketching**

*Definition:* Process should include the following:

- select and produce an appropriate pictorial style to best communicate solutions in the design process
- formulate pictorial sketches to develop ideas, solve problems, and understand relationships during the design process
- create sketches utilizing both the additive and subtractive methods to assess underlying geometric and perceptual principles
- select a sketching method that is efficient in its use of color, form, and symbols to represent abstract data
- augment pictorial sketches with shading to improve communication

Process/Skill Questions

**D 030: Annotated sketches**

*Definition:* Process should include the following:

- evaluate and select the necessary views to graphically communicate design solutions
- interpret annotated sketches in the design analysis process
- integrate annotated sketches in presentations, portfolios, and the documentation process
- develop properly annotated sketches to accurately convey data in a design solution

Process/Skill Questions

**DUTY E:****Geometric Relationships****Task:****E 010: Geometric forms and shapes**

*Definition:* Process should include the following:

- define and contrast points, lines, and line segments
- identify major geometric shapes (isosceles triangle, right triangle, scalene triangle, rectangles, squares, rhombus, trapezoid, pentagon, hexagon, and octagon)
- construct various geometric shapes, using a compass, ruler, and triangle
- define the elements and types of angles
- construct and bisect various types of angles, using a compass, ruler, and triangle
- define terminology associated with arcs and circles
- construct arcs, circles, and ellipses, using a compass, ruler, and triangle

Process/Skill Questions



**E 020: Geometric constraints**

*Definition:* Process should include the following:

- distinguish and define geometric constraints
- identify geometric constraints in a three-dimensional model (horizontal, vertical, parallel, perpendicular, tangent, concentric, collinear, coincident, and equal)

Process/Skill Questions

**E 030: Coordinate systems**

*Definition:* Process should include the following:

- apply the right hand rule to identify the X, Y, and Z axes of the Cartesian Coordinate System
- apply a combination of absolute, relative, and polar coordinates to construct a three-dimensional model
- define the origin planes in the Cartesian Coordinate System
- identify the origin and planar orientations of each side of a three-dimensional model

Process/Skill Questions

**DUTY F:  
Modeling****Task:****F 010: Conceptual modeling**

*Definition:* Process should include the following:

- demonstrate the creative-thinking process
- recognize the difference between vertical and lateral thinking
- categorize and select a solution to a problem
- communicate ideas through written and verbal formats

Process/Skill Questions

**F 020: Graphical modeling**

*Definition:* Process should include the following:

- identify the different graphical methods of data representation
- select the appropriate graphical format for a problem
- analyze and develop graphical representations of given data

Process/Skill Questions

**F 030: Physical modeling**

*Definition:* Process should include the following:

- develop an understanding of the different physical modeling techniques
- present a model with its correct proportions
- select the appropriate modeling materials to complete a three-dimensional model

Process/Skill Questions

**F 040: Mathematical modeling**

*Definition:* Process should include the following:

- evaluate a problem, using mathematical formulas
- analyze a solution to a problem, using the correct format of analysis

Process/Skill Questions

**F 050: Computer modeling**

*Definition:* Process should include the following:

- interpret a sketch by generating a model using a CAD software package
- explain the difference between parametric and adaptive designs, and specify their uses
- draw a two-dimensional sketch using a CAD package
- apply geometrical and dimensional constraints to a sketch
- demonstrate the ability to generate a three-dimensional model
- demonstrate the use of work features and how they are applied while constructing a solid model
- develop a computer model using work planes, axes, and points
- demonstrate the ability to modify a sketch or feature of a model

Process/Skill Questions

**DUTY G:****Assembly Modeling****Task:****G 010: Adding modeling components**

*Definition:* Process should include the following:

- understand and apply base components effectively in the assembly environment
- place and create components in the assembly-modeling environment
- create circular and rectangular patterns of components within an assembly model
- replace components with modified external parts
- perform part manipulation during the creation of an assembly model
- explore and demonstrate assembly-modeling skills by adding modeling components to solve a variety of design problems

Process/Skill Questions

**G 020: Assembly-modeling constraints**

*Definition:* Process should include the following:

- explore and demonstrate assembly-modeling skills using modeling constraints to solve a variety of design problems
- perform part manipulation during the creation of an assembly model
- apply assembly-modeling constraints to successfully construct a multipart object

Process/Skill Questions

**G 030: Part library**

*Definition:* Process should include the following:

- utilize part libraries effectively during the assembly-modeling process
- explore and demonstrate assembly-modeling skills using a part library

Process/Skill Questions

**G 040: Sub-assemblies**

*Definition:* Process should include the following:

- employ sub-assemblies during the production of assemblies
- explore and demonstrate assembly-modeling skills using sub-assemblies to solve a variety of design problems

Process/Skill Questions

**G 050: Drive constraints and motion simulation**

*Definition:* Process should include the following:

- understand and apply drive constraints to simulate the motion of parts in assemblies
- explore and demonstrate assembly-modeling skills using drive constraints and motion simulation to solve a variety of design problems

Process/Skill Questions

**G 060: Adaptive design**

*Definition:* Process should include the following:

- explore, understand, and apply adaptive design concepts during the development of sketches, features, parts, and assemblies
- explore and demonstrate assembly-modeling skills using adaptive design to solve a variety of design problems

Process/Skill Questions

**DUTY H:  
Modeling Analysis and Verification****Task:**

## **H 010: Mass properties**

*Definition:* Process should include the following:

- demonstrate how to extract mass-property data from solid models
- evaluate the accuracy of mass-property calculations
- describe how analysis data can be used to update parametric models
- list and explain the various mass-property calculations, such as volume, density, mass, surface area, centroid, moment of inertia, products of inertia, radii of gyration, principal axes, and principal moments
- explain how mass-property calculations are used to evaluate a parametric model

Process/Skill Questions

## **H 020: Tolerancing**

*Definition:* Process should include the following:

- interpret and use correct tolerancing techniques when dimensioning solid models
- demonstrate an understanding of how to solve tolerance problems, including limits and fits
- describe the differences between clearance fit, interference fit, and allowance

Process/Skill Questions

## **DUTY I: Model Documentation**

### **Task:**

## **I 010: Working drawings**

*Definition:* Process should include the following:

- select appropriate sheet size and title block for creating a drawing layout
- translate a three-dimensional drawing or model into corresponding orthographic drawing views
- describe the purpose and/or application of the following drawing views: isometric view, section view, auxiliary view, and detail view
- generate an isometric view from orthographic drawing views
- determine the correct section views required to illustrate an object's internal detail
- describe the purpose and application of hatch marks and a cutting plane line in a section drawing
- create the appropriate section view for a specified application
- create a detail view corresponding to an orthographic drawing view
- create an auxiliary view showing detail on an inclined surface of a drawing object

Process/Skill Questions

## **I 020: Dimensioning**

*Definition:* Process should include the following:

- list common dimensioning standards
- identify and demonstrate the use of common dimensioning systems
- describe characteristics and demonstrate the use of unidirectional and aligned dimensioning
- differentiate between the use of size dimensions and location dimensions
- demonstrate an understanding of size and location dimensions by applying dimensions to annotated sketches and drawings
- demonstrate appropriate dimensioning rules and practices
- set up and integrate use of a customized common dimensioning standard
- identify and demonstrate use of dimensioning practices on section, auxiliary, and assembly models
- define and demonstrate an understanding of tolerancing, and solve tolerance problems

Process/Skill Questions

## **I 030: Drawing notes**

*Definition:* Process should include the following:

- apply appropriate notes to sketches and drawings
- demonstrate an understanding of and formulate general and proprietary specifications to further communicate information relating to product design

Process/Skill Questions

## **DUTY J:**

### **Presentation**

#### **Task:**

## **J 010: Communication techniques**

*Definition:* Process should include the following:

- demonstrate communication techniques of voice variation, eye contact, posture, attire, practice and preparation, and projection of confidence
- demonstrate body language and gesture techniques for communications
- discuss how eye contact, posture, and attire can impact communications

Process/Skill Questions

**J 020: Presentation techniques**

*Definition:* Process should include the following:

- demonstrate an understanding of various forms of visual aids and their use in a presentation
- considering the audience and level of formality, select the most appropriate type of visual aid for a presentation
- considering the audience and level of formality, select the most appropriate type of written documentation for a presentation
- identify the elements of the various forms of written documentation

Process/Skill Questions

**DUTY K:  
Production****Task:****K 010: Manufacturing design analysis**

*Definition:* Process should include the following:

- recognize the need to involve all of the manufacturing team members in the decision-making process of designing a product
- categorize manufacturing specifications and constraints needed to produce a product
- evaluate material characteristics for manufacturing a specific product, and identify the correct manufacturing process needed to produce that product

Process/Skill Questions

**K 020: Process planning**

*Definition:* Process should include the following:

- evaluate and apply the correct machine process in planning for product manufacturing
- recognize the need to limit the number of processes used to manufacture a product
- develop an understanding of process routing in product manufacturing

Process/Skill Questions

**K 030: Design for automated manufacturing**

*Definition:* Process should include the following:

- distinguish the differences between CNC, FMS, and CIM

Process/Skill Questions

**K 040: Materials, procurement, handling, and cost analysis**

*Definition:* Process should include the following:

- explain the need for a company to minimize material handling by procurement of materials in a timely fashion
- explain the JIT process
- identify the need to perform a cost analysis of a product

Process/Skill Questions

**K 050: Quality control**

*Definition:* Process should include the following:

- interpret statistically analyzed data to ensure product quality

Process/Skill Questions

**K 060: Manpower and facility requirements**

*Definition:* Process should include the following:

- identify the need to evaluate manpower
- identify the need to evaluate facility requirements

Process/Skill Questions

**K 070: Packaging**

*Definition:* Process should include the following:

- recognize the need to protect a product for shipping
- analyze aesthetic requirements to enhance packaging for the consumer

Process/Skill Questions

**DUTY L:  
Marketing****Task:****L 010: Product analysis**

*Definition:* Process should include the following:

- define, explain, and demonstrate an understanding of common vocabulary words used in association with product cost analysis
- formulate a product cost analysis for a given product

Process/Skill Questions

**L 020: Packaging requirements**

*Definition:* Process should include the following:

- demonstrate an understanding of packaging design requirements
- design a package for a given product

Process/Skill Questions



**Task Definitions**  
**Digital Electronics**

**DUTY A:**

**Analog and Digital Fundamentals**

**Task:**

**A 010: Voltage, current, and resistance**

*Definition:* Process should include the following:

- demonstrate how to calculate the resistance, current, and voltage using Ohm's Law
- demonstrate the use of a multimeter to determine voltage, resistance, and current in a simple circuit
- demonstrate the ability to read and understand resistor color codes

Process/Skill Questions

**A 020: Kirchhoff's Law**

*Definition:* Process should include the following:

- demonstrate an understanding of how a variety of voltage sources can be applied to a circuit
- build single source series and parallel circuits
- apply Kirchhoff's voltage and current laws to closed loop circuits
- use electrical meters to measure electrical parameters in a circuit

Process/Skill Questions

**A 030: Introduction to digital electronics**

*Definition:* Process should include the following:

- demonstrate an understanding of how digital logic consists of the application of Boolean algebra to the solution of logical problems
- demonstrate an understanding of how true and false, one and zero (voltages that indicate logic highs and lows) are used in the practical implementation of digital logic
- demonstrate an understanding of how combinations of inputs applied to digital components can be used to implement logical statements
- differentiate between digital and analog systems
- use the logic probe and the multimeter to measure digital signals

Process/Skill Questions

## **A 040: Analog and digital waveforms**

*Definition:* Process should include the following:

- identify analog and digital waveforms, and differentiate between the two
- demonstrate an understanding of how voltage levels in digital waveforms represent logic levels
- demonstrate an understanding of waveform characteristics, such as duty cycle, frequency, and amplitude
- demonstrate the proper use of a logic probe

Process/Skill Questions

## **DUTY B: Number Systems and Binary Addition**

### **Task:**

## **B 010: Counting and converting number systems**

*Definition:* Process should include the following:

- count in binary, octal, hexadecimal, and BCD number systems
- convert between different number systems

Process/Skill Questions

## **B 020: Adding and subtracting binary numbers**

*Definition:* Process should include the following:

- add and subtract positive binary numbers
- apply 1's complement and 2's complement for subtracting binary numbers

Process/Skill Questions

## **B 030: Encoding decimal numbers to binary format**

*Definition:* Process should include the following:

- using a simulation circuit, demonstrate that logic circuits can encode a decimal number to the binary format
- demonstrate how logic circuits decode a decimal number to the binary format by using a simulated circuit

Process/Skill Questions

## **DUTY C: Introduction to Logic Gates**

### **Task:**

**C 010: Logic gates**

*Definition:* Process should include the following:

- explain the operation, draw the logic symbols, and write the Boolean expressions of the five basic logic functions: AND, OR, NAND, NOR, NOT
- summarize the enable/inhibit functions of two input AND, OR, NAND, and NOR gates.
- draw and construct expanded gate circuits from two input gates
- construct a test circuit, and evaluate the operation in the form of a truth table of the five basic gates: AND, OR, NAND, NOR, NOT

Process/Skill Questions

**C 020: Duality of logic functions**

*Definition:* Process should include the following:

- demonstrate that by using the NAND gate, all logic functions can be developed
- demonstrate that by using the NOR gate, all logic functions can be developed

Process/Skill Questions

**C 030: The exclusive OR and exclusive NOR functions**

*Definition:* Process should include the following:

- explain the operation, develop the truth table, write the Boolean expression, and draw the logic symbol of the exclusive OR (XOR) gate
- explain the operation, develop the truth table, write the Boolean expression, and draw the logic symbol of the exclusive NOR (XNOR) gate
- build and test a half adder circuit, using an exclusive OR gate and an AND gate
- build a comparator, using four exclusive OR gates to compare two 4-bit words

Process/Skill Questions

**DUTY D:****Digital Logic Specifications and Families****Task:****D 010: IC specifications**

*Definition:* Process should include the following:

- identify different digital families (CMOS and TTL), and describe their limitations
- interpret data sheets to determine the range of logic high and logic low voltage levels, propagation delay, and other properties
- demonstrate an understanding of the characteristics common to specific logic families
- demonstrate proper techniques for interfacing TTL and CMOS families
- demonstrate the proper handling techniques for CMOS and TTL circuitry

Process/Skill Questions

<b>DUTY E:</b> <b>Boolean Algebra and Circuit Design</b>
<b>Task:</b>
<b>E 010: Boolean expressions for combinational circuits</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• explain the relationship between Boolean expressions and truth tables</li> <li>• develop the Boolean expression given a truth table</li> <li>• prove DeMorgan's theorems by constructing, testing, demonstrating, and verifying the operation of the appropriate circuit</li> <li>• simplify Boolean expressions using Boolean Algebra and Karnaugh Mapping</li> <li>• construct and test a logic circuit to implement a truth table</li> </ul> Process/Skill Questions
<b>E 020: Waveform logic</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• demonstrate an understanding of the relationship between logic waveforms and truth tables</li> <li>• select an appropriate gate to produce a given waveform</li> </ul> Process/Skill Questions
<b>E 030: Decimal to BCD encoder</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• apply integrated circuit chips to the design of a complex combinational circuit</li> </ul> Process/Skill Questions
<b>E 040: Combinational logic</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• given the truth table of a combinational logic circuit, determine the logic equation and the logic circuit</li> <li>• given the logic circuit, construct the truth table, and determine the logic equation</li> </ul> Process/Skill Questions

## **E 050: Practical applications of combinational logic**

*Definition:* Process should include the following:

### Majority Vote System

- develop the Boolean expression to verify the truth table for a majority vote system
- use a logic probe to test and evaluate the circuit

### Binary Coded Decimal to Seven-segment Display Decoding

- create a truth table for a circuit that will output the decimal numbers 0-9 on a seven-segment display from the BCD numbers 0-9
- derive the Boolean expression to verify the truth table for a BCD to seven-segment display decoder
- build a discrete gate circuit from a simplified Boolean expression obtained from a truth table

### Automobile Alarm System

- Construct and test a start/alarm system for an automobile ignition system

Process/Skill Questions

## **DUTY F:**

### **Binary Adders and Subtractors**

#### **Task:**

## **F 010: Adder and subtractor design**

*Definition:* Process should include the following:

- demonstrate an understanding of the function of the half adder
- demonstrate an understanding of the truth table for a half adder
- demonstrate an understanding of the function of the full adder
- demonstrate an understanding of the truth table for a full adder
- develop higher order adders by combining several full adders
- understand the design of subtractors, using 1's complement and 2's complement

Process/Skill Questions

**Task Definitions**  
**Principles of Engineering**

<b>DUTY A:</b>
<b>Overview and Perspective of Engineering</b>
<b>Task:</b>
<p><b>A 010: What is engineering?</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• demonstrate an understanding of engineering, and be able to identify engineering achievements through history</li> <li>• identify five engineering role models, including minorities and women</li> <li>• define attributes associated with being a successful engineer</li> <li>• identify problems for engineers to solve in the future</li> </ul> <p>Process/Skill Questions</p>
<p><b>A 020: Career choices in engineering</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• develop an understanding of the difference between engineering discipline and job functions</li> <li>• develop an understanding of the professional and legal responsibilities associated with being an engineer</li> </ul> <p>Process/Skill Questions</p>
<p><b>A 030: The engineering case study</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• compare and contrast engineering disciplines from engineering job functions that are needed to complete the final design of a given case study</li> <li>• discuss the legal and ethical issues related to a final design developed in a given case study</li> </ul> <p>Process/Skill Questions</p>
<b>DUTY B:</b>
<b>Communications in Engineering</b>
<b>Task:</b>
<p><b>B 010: Written and oral communication</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• demonstrate an understanding of and use a design brief format</li> <li>• construct a resume using the personal and professional data of a well-known engineer</li> <li>• prepare and use presentation graphics to communicate a resume</li> </ul> <p>Process/Skill Questions</p>

**B 020: Graphic representation of numerical data**

*Definition:* Process should include the following:

- explain elements of graphic design that assist in communication
- demonstrate an ability to effectively present numerical data in an accurate, appropriate form

Process/Skill Questions

**B 030: Computer aided design**

*Definition:* Process should include the following:

- use a CAD system to model a simple product
- use a CAD system to determine some basic properties of the product
- use a CAD system to understand the types of rapid prototyping systems and their applications

Process/Skill Questions

**DUTY C:****The Process of Engineering****Task:****C 010: The problem-solving method**

*Definition:* Process should include the following:

- apply the problem-solving method to a hypothetical engineering problem

Process/Skill Questions

**C 020: The team approach to engineering**

*Definition:* Process should include the following:

- develop an understanding of how an engineering team must work together to solve problems
- discuss the “individual and collective responsibility” of each member of a team
- develop an understanding of the role of out-sourcing in the engineering process and how effective communication is essential throughout this process
- develop an understanding of how gender bias, racial bias, and other forms of stereotyping and discrimination can adversely affect communications within an engineering team
- develop an understanding of how ethics influence the engineering process
- develop an understanding of how social, environmental, and financial constraints influence the engineering process

Process/Skill Questions

### **C 030: Engineering and engineering technology career pathways**

*Definition:* Process should include the following:

- identify the engineering categories
- explain the major work opportunities available to engineers and the engineering function practiced by each
- explain the educational requirements necessary for careers in engineering and engineering technology
- evaluate an existing product to determine which area of engineering was responsible for each phase of the product development, distribution, and service

Process/Skill Questions

#### **DUTY D: Engineering Systems**

##### **Task:**

#### **D 010: Mechanical mechanism systems**

*Definition:* Process should include the following:

- identify and develop an understanding of essential components of mechanical mechanism systems
- develop effective presentation skills using a presentation on a mechanical mechanism system
- assess the effectiveness of a presentation on the mechanical mechanism system

Process/Skill Questions

#### **D 020: Electro-mechanical systems**

*Definition:* Process should include the following:

- identify and develop an understanding of essential components of an electro-mechanical system
- develop effective presentation skills using a presentation on an electro-mechanical system
- assess the effectiveness of a presentation on an electro-mechanical system

Process/Skill Questions

#### **D 030: Hydraulic systems**

*Definition:* Process should include the following:

- identify and develop an understanding of essential components of a hydraulic system
- develop effective presentation skills using a presentation on a hydraulic system
- assess the effectiveness of a presentation on a hydraulic system

Process/Skill Questions



**D 040: Pneumatic systems**

*Definition:* Process should include the following:

- identify and develop an understanding of essential components of a pneumatic system
- develop effective presentation skills using a presentation on a pneumatic system
- assess the effectiveness of a presentation on a pneumatic system

Process/Skill Questions

**D 050: Motors and generators**

*Definition:* Process should include the following:

- identify and develop an understanding of essential components of motors and generators
- develop effective presentation skills using a presentation on motors and generators
- assess the effectiveness of a presentation on motors and generators

Process/Skill Questions

**D 060: Control systems**

*Definition:* Process should include the following:

- design and build a computer-controlled model that is monitored by various sensors to perform a specific task
- evaluate subsystems for their potential application into a total model design
- analyze and optimize the results of a control system design

Process/Skill Questions

**DUTY E:****The Manufacturing Process in Engineering****Task:****E 010: Precision measurement**

*Definition:* Process should include the following:

- convert from one unit of length in a measuring system to another unit within the same system
- describe the difference between mass and weight
- utilize precision measurement tools to measure appropriate dimensions, mass, and weight
- use precision measurements to determine unknown materials

Process/Skill Questions

## **E 020: Quality assurance and process control**

*Definition:* Process should include the following:

- develop an understanding of and explain why companies have a need for quality control
- describe what customers and companies refer to when the term “quality” is used
- explain the difference between process and product
- distinguish between characteristics of quality in a final product and the control of quality in each step of a process
- calculate the mean, median, mode, and standard deviation for a set of data, and apply that information to an understanding of quality assurance
- develop an understanding of how control charts are used in industry
- predict whether a process is “out of control” by using a control chart
- explain in everyday language what is meant by concurrent and simultaneous engineering
- describe steps modern companies use to assure they are competitive in today’s international market

Process/Skill Questions

## **E 030: Production processes**

*Definition:* Process should include the following:

- explain the major separating processes and give examples of each
- explain the major metal-forming processes and give examples of each
- explain the major plastic-forming procedures and give examples of each
- explain the major fastening processes and give examples of each
- explain the major conditioning processes and give examples of each
- explain the major finishing processes and give an example of each

Process/Skill Questions

## **E 040: Computer-aided manufacturing**

*Definition:* Process should include the following:

- trace the evolution of machine tools to present day technology
- develop an understanding of the terminology associated with NC, CNC, FMS, CAD, and CAM
- develop an understanding of CAD/CAM in the manufacturing process
- use CAD and produce products with NC and CNC machine tools
- develop an understanding of the design parameters and performance characteristics of robots
- develop an understanding of the concept of concurrent engineering and flexible manufacturing systems

Process/Skill Questions

**DUTY F:**  
**Materials and Materials Testing in Engineering**

**Task:**

**F 010: Categories of materials**

*Definition:* Process should include the following:

- demonstrate knowledge of the properties of materials
- define technological terms related to materials
- identify and classify the four basic categories of solid engineering materials
- compare and contrast the physical properties of metals, polymers, ceramics, and composites
- identify practical applications of each material category to engineered products and processes
- collect, analyze, and test samples of the four basic materials
- document laboratory data related to studies of material classifications
- develop a presentation on laboratory data related to studies of material classifications, using written, oral, and multimedia techniques

Process/Skill Questions

**F 020: Properties of materials**

*Definition:* Process should include the following:

- distinguish the differences between the major property categories of materials
- describe major classifications of material properties
- develop an understanding of and document the properties of materials
- formulate conclusions through analysis of recorded laboratory test data
- interpret and prepare data for presentations in the form of charts, graphs, written, verbal, and multimedia formats

Process/Skill Questions

**F 030: Material-testing processes**

*Definition:* Process should include the following:

- describe and conduct destructive and non-destructive material testing
- use the data collected from destructive and non-destructive material testing to compute mechanical properties
- use definitions of pertinent technological terms to categorize materials
- use test equipment safely
- observe performance reactions of materials to testing
- collect, record, and analyze test data
- use test data to compute and document mechanical properties of materials and present interpreted test results

Process/Skill Questions

**F 040: Material suitability and application**

*Definition:* Process should include the following:

- develop an understanding of the accepted criteria and standards of appropriate materials applications
- using the design brief format, communicate appropriate applications criteria and standards through a selected materials application case study presentation
- evaluate the relationship between product performance and the materials selected for construction
- analyze samples of consumer product materials, emphasizing material selection and suitability for production

Process/Skill Questions

**Task Definitions**  
**Computer Integrated Manufacturing**

<b>DUTY A:</b>
<b>Computer Modeling</b>
<b>Task:</b>
<p><b>A 010: Fundamentals of computer modeling</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• demonstrate the ability to store, retrieve copy, and output computer drawing files</li> <li>• utilize 2D computer-sketching functions</li> <li>• incorporate coordinate systems in the construction of 2D geometric shapes</li> <li>• calculate the x and y coordinates for a point given a radius and angle</li> </ul> <p>Process/Skill Questions</p>
<p><b>A 020: Object construction</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• produce 2D sketches using available computer-sketching features</li> <li>• apply editing techniques to produce accurate computer sketches</li> <li>• demonstrate an understanding of and apply sketch constraints</li> <li>• analyze drawings with appropriate inquiry functions</li> </ul> <p>Process/Skill Questions</p>
<p><b>A 030: Parts modeling</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• define computer-sketched objects with dimensions and geometric constraints</li> <li>• apply necessary sketched features to generate a solid model</li> <li>• demonstrate the application and modifying of features on a computer-generated sketch</li> </ul> <p>Process/Skill Questions</p>
<p><b>A 040: Creation of drawing views</b></p> <p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• develop drawing views from a solid model (top, front, right side, isometric, section, auxiliary)</li> <li>• demonstrate the proper application of annotations, and reference dimensions conforming to established drafting standards</li> <li>• update model and drawing views, using revision specification sheets</li> </ul> <p>Process/Skill Questions</p>

**A 050: Assembly modeling**

*Definition:* Process should include the following:

- create assembly models through the integration of individual parts and sub-assemblies
- generate an assembly drawing, including views, balloons, and bill of materials (BOM)

Process/Skill Questions

**A 060: Rapid prototyping**

*Definition:* Process should include the following:

- describe the array of industry-wide prototyping methods in use
- identify the need for rapid prototyping
- prepare a prototype model from a drawing database

Process/Skill Questions

**DUTY B:  
Programmable Machines****Task:****B 010: The history of programmable machines**

*Definition:* Process should include the following:

- explain the history of Computer Controlled Machines, charting the growth of NC and how it has been implemented into private industry
- explain how the application of CNC machines has impacted manufacturing
- explain the advantages and disadvantages of CNC Machining
- chart the evolution of machine tools, controllers, and software used in programmable machines
- explore career opportunities and educational requirements within the field of programmable machines

Process/Skill Questions

## **B 020: CNC characteristics**

Definition: Process should include the following:

- identify the axis relative to various CNC machines
- contrast open and closed loop control systems
- identify types of drive systems used in CNC
- use the CNC control program to indicate the machine position, and then contrast that position to the relative position of the part origin (PRZ)
- identify and explain the function of the major components of a CNC machine tool
- apply various work-holding devices commonly used for CNC machining
- identify various types of tool changers used in CNC machine tools
- define the three primary axes used in CNC machining, and explore the remaining axes used in advanced machining
- explain the importance of cutting tool material and how it will affect the speed and feed rates used by machine tools
- examine different types of tool-holding devices used in CNC machine tools
- select appropriate cutting tools to efficiently, safely, and accurately cut parts using a CNC machine

Process/Skill Questions

## **B 030: CNC programming**

*Definition:* Process should include the following:

- describe the difference between reference points and position points
- develop an understanding of CNC machine movements identified by axes
- develop an understanding of the axis system as a worldwide standard for machine movement
- plot points, using absolute, relative (incremental), and polar coordinates
- identify Significant Points on geometric shapes (center point, end point)
- identify the optimum location for the Program Reference Zero (PRZ) point
- identify the three categories of machine movement (straight line, curved line, and non-regular shape)
- complete a preliminary planning sheet, identifying necessary work-holding devices, cutting tools, reference points, machining sequences, and safe operation
- define the terms “Alphanumeric Coding, G Codes, and M Codes”
- identify the three sections of a program: initial commands, program body, and program end
- write a basic NC part program using necessary G and M codes, including remarks that describe the function of each code
- explore the advantages and disadvantages of shop-floor programming as well as off-line programming
- create a simple NC part program, using a text editor and a CAM package
- employ a CAD/CAM/CNC software solution to create a part
- analyze, identify, and correct errors found in NC part program files
- utilize simulation software to graphically verify NC program operation
- perform a “dry run” to verify the machine setup and program operation

Process/Skill Questions



## **B 040: CNC operations**

*Definition:* Process should include the following:

- demonstrate the ability to safely set up, maintain, and operate a CNC machining center, using appropriate documentation and procedures
- analyze part geometry to select appropriate cutting tools and fixturing devices needed to create a part using a CNC machine
- set up and edit the tool library of a CNC control program, providing offset values and tool geometry
- calculate and verify appropriate spindle speeds and feed rates specific to each cutting tool utilized in an NC part program
- safely and accurately fixture a part in a CNC machine, set the program reference zero (PRZ), and verify NC part programs, using simulation software before machining the part on a CNC device
- list and demonstrate all methods of disabling a CNC machine in the event of an emergency
- follow a safety checklist prior to running an NC part program on a CNC machine
- Perform a dry run to verify the machine setup and program operation
- operate a CNC machine to cut a part to specifications

Process/Skill Questions

## **B 050: Precision measurement**

*Definition:* Process should include the following:

- measure using standard and metric systems
- convert measurements between metric and standard inch systems
- interpret technical drawings, identifying and understanding dimensional tolerances and limits
- make precision measurements to the degree of accuracy required by plan specification, using appropriate instruments
- develop an understanding of how comparison instruments can be used to check dimensions, compare shapes, indicate centers, and check parallel surfaces
- develop an awareness of advanced and automated measurement systems that are applied in industry (coordinate measuring systems, digital probes, and optical scanners)
- develop an awareness of the importance of precision measurement in SPC and quality control

Process/Skill Questions

## **B 060: CAM software**

*Definition:* Process should include the following:

- define the acronym CAM, and explain the purpose of a CAM package
- demonstrate the ability to operate the user interface of a CAM package and access help using appropriate documentation and help screens
- perform basic file operations, using a CAM package such as saving, opening, printing, and editing part program files
- demonstrate the ability to import and export CAD files using a CAM package
- set up a CAM package by editing the material and tool libraries, defining stock sizes, selecting the appropriate post processor, and defining the units of measure to be used
- define and apply the fundamental and advanced milling and turning procedures used in CAM packages
- use a CAM package to generate and edit tool paths by applying appropriate machining processes to geometry imported from a CAD program

Process/Skill Questions

## **DUTY C:**

### **Introduction to Robotics**

#### **Task:**

## **C 010: Introduction to robotics**

*Definition:* Process should include the following:

- explore the chronological development of automation leading to robotics
- investigate career opportunities in robotics career fields
- demonstrate the development of robotics from science fiction
- identify a minimum of four dangerous and repetitive jobs in which robots are used
- Process/Skill Questions

## **C 020: Robotics and automated systems**

*Definition:* Process should include the following:

- formulate a definition of a robot
- classify different types of robots
- evaluate the positive impact robots have on manufacturing
- discuss the social implications of robots

Process/Skill Questions

**C 030: Robot characteristics**

*Definition:* Process should include the following:

- identify and compare the four classifications of robots
- investigate a classification of robots
- design and build a working model of a robot
- identify and report specifications and work envelopes of robots

Process/Skill Questions

**C 040: Mechanical components**

*Definition:* Process should include the following:

- identify and sketch the mechanical components for a robot
- design and develop an end effector
- demonstrate an understanding of how end effectors are specific to a process
- demonstrate an understanding of various drive systems used in robotics, and analyze the advantages and disadvantages of each

Process/Skill Questions

**C 050: Control systems**

*Definition:* Process should include the following:

- develop an understanding of the basic components of robot controllers
- demonstrate an understanding of control techniques and computer simulations
- design and build a feed system with sensors

Process/Skill Questions

**C 060: Programming methods**

*Definition:* Process should include the following:

- program a robot to perform several tasks
- program a robot to solve a materials-handling problem
- recognize the need for end-of-arm tooling and how this tooling affects the robot's operation

Process/Skill Questions

**C 070: Industrial robot applications**

*Definition:* Process should include the following:

- develop an understanding of the necessity for specialty tooling applications in robotics
- prepare and document a presentation on end-of-arm tooling

Process/Skill Questions

**DUTY D:**  
**Computer-integrated Manufacturing**

**Task:**

**D 010: Rationale for CIM**

*Definition:* Process should include the following:

- demonstrate an understanding of how individual components of a flexible manufacturing system are interrelated
- recognize the benefits and problems associated with CIM technology and how they affect the manufacturing process
- identify basic characteristics of a manufacturing operation that lend themselves to computer-integrated manufacturing
- identify some of the typical components and subsystems that make up an automated machining, assembly, and process-type manufacturing operation

Process/Skill Questions

**D 020: Types of CIM systems**

*Definition:* Process should include the following:

- identify the three categories of CIM systems
- compare and contrast the benefits and drawbacks of the three categories of CIM systems
- recognize the working relationship between the CNC mill and the robot
- identify the components of an FMS

Process/Skill Questions

**D 030: Components of CIM systems**

*Definition:* Process should include the following:

- identify and study the relationship between a CNC milling machine interface and a jointed-arm robot interface through a communication handshaking process
- explore the individual components used in selected CIM systems
- analyze and select components of a CIM system for a specific industrial application
- demonstrate an understanding of various applications of a Programmable Logic Controller as related to its use in a CIM system
- demonstrate an understanding of the difference between a PLC and a computer with an interface

Process/Skill Questions

#### **D 040: CIM system applications**

*Definition:* Process should include the following:

- recognize and demonstrate an understanding of the necessary safety precautions associated with a fully automated CIM system
- recognize and explain the significance of teamwork and communication to combine the designs of individual groups into a complete miniature FMS
- demonstrate an understanding of how individual components work together to form a complete CIM system
- assemble and test individual component designs by integrating them into a complete miniature FMS model

Process/Skill Questions

**Task Definitions**  
**Civil Engineering and Architecture**

<b>DUTY A:</b>
<b>Comparison of Civil Engineering and Architecture</b>
<b>Task:</b>
<b>A 010: Concept map of civil engineering and architecture</b>
<p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• document your understanding of civil engineering and architecture</li> <li>• identify parallels between civil engineering and architecture</li> <li>• identify projects in your community that were primarily planned by architects</li> <li>• identify projects in your community that were primarily planned by civil engineers</li> </ul> <p>Process/Skill Questions</p>
<b>A 020: Civil engineering and architecture overview</b>
<p><i>Definition:</i> Process should include the following:</p> <ul style="list-style-type: none"> <li>• discover differences between civil engineering and architecture.</li> <li>• explore the historical impacts of important developments such as the pyramids and architectural styles</li> <li>• describe how developments in architecture influenced the progress of humankind</li> <li>• describe effects the pyramids, aqueducts, etc. have had on the evolution of civil engineering and architecture</li> <li>• discuss how the roles of various stakeholders relate to the development of a civil engineering or architectural project</li> </ul> <p>Process/Skill Questions</p>
<b>DUTY B:</b>
<b>Introduction to Projects</b>
<b>Task:</b>

## **B 010: Overview of project design**

*Definition:* Process should include the following:

- utilize the design process and common practices to develop a viable solution to a small project
- describe how project documentation is accomplished
- utilize critiques and reviews to provide suggestions for improvement of a project
- develop a presentation of the solution for a small project
- describe how project documentation is necessary to solve complex design problems and provide accurate communication
- develop an understanding of how people work in teams to produce solutions to complex problems
- develop an understanding of how designs continuously evolve as they are developed

Process/Skill Questions

## **B 020: Project documentation**

*Definition:* Process should include the following:

- describe why the ability to create a rapid, accurate sketch is an essential skill of graphic communication
- describe how journals are used to document the design process
- create a structure to document work for the year, including portfolio components, sketches, journals, specifications manual, and working drawings
- prepare a portfolio for a given situation
- use critiques and reviews to inform and provide suggestions for improvement of a presentation or display of work
- describe how project documentation with working drawings and specifications is used to convey the final design solution of a project

Process/Skill Questions

## **DUTY C:**

### **Project Planning**

#### **Task:**

## **C 010: Site information--Discovery**

*Definition:* Process should include the following:

- research information on a site to develop, including past owners, uses, adjoining property uses, covenants, wetlands, etc. that might restrict development options
- research where to locate maps, current owner, and previous owner information
- as part of a study group, report the findings on site discovery, regulations, and generic viability analysis
- discuss how the selection of a site and the project planned must be interrelated

Process/Skill Questions

## **C 020: Site information--Regulations**

*Definition:* Process should include the following:

- discuss how civil engineering and architectural projects are constrained by federal, state, and local regulations
- identify the functions of regulatory agencies for civil engineering and architectural projects in your community
- describe the permitting and approval process for civil engineering and architectural projects in your community
- distinguish between municipal regulations, archaeological considerations, environmental limitations, covenants, deeds, and restrictions

Process/Skill Questions

## **C 030: Site information --Generic Viability Analysis**

*Definition:* Process should include the following:

- describe how the support structure of the surrounding area determines the viability of a project
- perform a survey of the area surrounding a project, including such items as types of services, hotel information, shopping, airports, highways, places of interest, parking, places of worship, parks, and convention centers
- evaluate and report the findings of a survey in regard to surroundings, infrastructure, traffic flow, utilities, considerations/constraints, neighbors, zoning, and lot size

Process/Skill Questions

## **C 040: Development options and project selection**

*Definition:* Process should include the following:

- discuss development options, giving consideration to the constraints for a given site
- evaluate the characteristics of a given site regarding positive and negative impacts for development
- as part of a study group, debate the selection of development for a given site
- as part of a study group, report the findings on site discovery, regulations, and generic viability analysis

Process/Skill Questions



## **C 050: Revisiting viability analysis**

*Definition:* Process should include the following:

- review and re-evaluate information from a viability analysis in regard to use of a site for a specific purpose
- evaluate information about the types of services available to a likely user of a selected project
- as part of a study group, report the consensus on a project design and the discussions regarding the generic viability analysis

Process/Skill Questions

## **DUTY D: Site Planning**

### **Task:**

## **D010: Site-planning concepts**

*Definition:* Process should include the following:

- discuss how designers maximize potential of a property, minimize impact on the environment, and create an attractive visual space
- describe how codes and building requirements define and constrain the location of structures on a site
- discuss utility/service requirements based on the planned use of a site

Process/Skill Questions

## **D 020: Description of property**

*Definition:* Process should include the following:

- interpret a legal description of a piece of property
- search for legal descriptions on the Internet
- research various zoning designations used by local municipalities
- identify improvements that are allowed for various zoning designations
- describe how topography of a site constrains the use of the site

Process/Skill Questions

## **D 030: Site plan requirements**

*Definition:* Process should include the following:

- discuss how space allocations must reflect the needs of the user and establish effective circulation for a site
- interpret contour maps and lines for a project site
- develop a bubble diagram, using a plot plan and project site requirements for use in creating a site plan

Process/Skill Questions

**D 040: Site plan layout**

*Definition:* Process should include the following:

- identify the impact that site topography will have on the location of structures on a site
- identify the impact local, state, and federal regulations have on the location of structures
- describe how the availability of utilities impacts structure design and placement
- describe enhancements to visual impact made by aesthetics and building orientation
- convert a bubble diagram to building footprints on a plot plan
- explore utility corridors, lot coverage and setbacks, and building footprint
- develop and evaluate a site plan in regard to wetland identification and protection, frontage, easements, utility right of way, setbacks, utility availability and corridors, building size and orientation

Process/Skill Questions

**D 050: Public ingress/egress**

*Definition:* Process should include the following:

- evaluate appropriateness of planned ingress and egress
- determine increased impacts from planned ingress and egress
- research how local codes determine the type, sizing, and placement of ingress and egress
- develop an understanding of public ingress and egress, including roadways, pathways, sidewalks, off-street parking, signage and markings, lighting, and universal access

Process/Skill Questions

**D 060: Site grading**

*Definition:* Process should include the following:

- evaluate a project in regard to subsurface conditions, topographic design and storm water management, topsoil, cut and fill balances, excavation, and site grading
- discuss ways in which site topography is altered to meet the requirements of the design
- discuss how subsurface conditions define the scope and equipment necessary to accomplish site grading
- identify considerations necessary for soil borings, types of soils, drainage, swales, drainage ponds, grading cuts, and fills

Process/Skill Questions

**D 070: Site utility requirements**

*Definition:* Process should include the following:

- discuss site considerations requiring design and construction of substations
- discuss concepts of right of way and easement regarding a project
- identify environmental impact of various designs for a project
- identify methods for utility transmission to a project site
- research advantages and disadvantages of above- and below-ground utilities for a project
- investigate utility sizing and specifications required for a project
- research and report on various requirements for utilities for a project, including source, easements, transmission, distribution, sizing, and alternate sources

Process/Skill Questions

**D 080: Site landscaping**

*Definition:* Process should include the following:

- describe how plant groupings, planting requirements, sizing, and species selection are used in landscaping to improve esthetics and/or manage the environment of a project
- discuss local conditions and resources used in the design of landscaping
- describe how landscaping is used to provide sight and noise buffers to adjacent structures
- discuss landscaping considerations for function, green space, irrigation, and xeriscape (water-efficient landscaping appropriate to the environment)

Process/Skill Questions

**DUTY E:****Architecture Design Process****Task:****E 010: Architectural considerations in project design**

*Definition:* Process should include the following:

- discuss the considerations of environment, esthetics, structural integrity, and the safety of occupants in addition to livability and suitability in developing a responsible project design
- discuss how considerations for cost and functionality impact design decisions
- identify reasons why graphic communication is essential to successful implementation of a design project
- give reasons for mathematics as an important tool in the design process
- describe reasons for maintaining architectural style in a project design
- investigate the history and development of an architectural style
- create a presentation providing information on the elements of an architectural style

Process/Skill Questions

## **E 020: Floor plans**

*Definition:* Process should include the following:

- describe how the floor plan conveys information on spatial relationships and design elements that make spaces function properly
- describe the necessity of information on a floor plan to the understanding of a project design
- prepare a floor plan, giving consideration to arrangement of spaces, building envelope, windows, doors, wall types, floor types, equipment layout, universal accessibility, and vertical transport
- utilize bubble diagrams and design software to apply good design practices--including traffic flow, room usage, and human needs--in developing a floor plan
- 

Process/Skill Questions

## **E 030: Energy systems**

*Definition:* Process should include the following:

- discuss how local codes and restrictions provide input into the design of a structure's energy systems
- describe how designs can be altered to maximize energy loss
- demonstrate energy loss calculations
- perform an energy audit for a building or project
- describe the impacts that door and window sizes have on energy calculations
- describe how information on the floor plan is related to the HVAC design of a structure
- address minimum code requirements, green building options, smart building technologies, utility cost analysis, and emerging custom measures in development of an HVAC plan

Process/Skill Questions

## **E 040: Elevations**

*Definition:* Process should include the following:

- describe how building elevations give graphic visualization and critical information about the design elements in vertical orientation
- develop elevations of a structure, giving exterior details and materials
- develop interior elevations of a structure, giving interior details and materials
- utilize building sections to describe interior details that are difficult to visualize
- describe scale considerations to emphasize or clarify a particular aspect of detail
- develop a typical wall section, detailing the cornice, roof edge, head, sill, and other features of a structure

Process/Skill Questions

**E 050: Sections and details**

*Definition:* Process should include the following:

- identify purposes for developing interior and exterior details and sections
- describe reasons for various scales used with interior and exterior details and sections
- develop typical wall section drawings for interior and exterior walls of a building
- indicate construction details for the cornice, roof edge, head, sill, brick features, and other features on a typical wall section

Process/Skill Questions

**E 060: Schedules**

*Definition:* Process should include the following:

- describe how schedules are used to organize and provide critical information on construction drawings
- identify items and information found on door, window, and finish schedules
- prepare door and window schedules for a building, including information on manufacturers, products, finish, and size
- prepare a finish schedule coordinated with the floor plan for the interior of a building, including finish materials for floors, walls, and ceilings

Process/Skill Questions

**E 070: Mechanical systems**

*Definition:* Process should include the following:

- describe how designers anticipate the mechanical system needs and requirements of the client
- describe considerations necessary to size the mechanical systems for a building
- describe limitations, minimum requirements, and design considerations for mechanical systems brought about by local codes
- research and develop diagrams for risers, air handling, air cleaning, etc.
- research types of heating systems available for a building
- evaluate the energy requirements for a building
- calculate the size of HVAC equipment for a building

Process/Skill Questions

## **E 080: Electrical systems**

*Definition:* Process should include the following:

- develop an electrical plan related to the floor plan of a building, including electrical panel location, sizing, feeds, and subfeeds
- evaluate both functional and esthetic lighting needs, and develop a reflected ceiling plan for a building
- discuss how local codes dictate and influence minimum electrical requirements for a building, including the size and type of circuits and the location of components
- describe how convenience, usage, cost, and esthetics affect the electrical plan of a building
- describe the kinds and type of information that is communicated on an electrical plan

Process/Skill Questions

## **E 090: Protection systems**

*Definition:* Process should include the following:

- discuss how local codes dictate and influence protection and security requirements for a building, including the size and type of circuits and the location of components
- discuss how protection and security systems are used to provide for the well-being of the users of a building
- evaluate both security and protection needs, and develop a protection system plan for a building, including fire, smoke, and gas detection systems and fire suppression and security systems

Process/Skill Questions

## **DUTY F: Structural Engineering**

### **Task:**

## **F 010: Structural engineering overview**

*Definition:* Process should include the following:

- discuss how the use of a structure, who will use it, the conditions under which it will be used, and the geometric shapes it will be composed of affect the structural design of a building
- describe reasons for a designer to take into consideration the environment, esthetics, structural integrity, and safety of the building occupants in a building design
- identify reasons why graphic communication is essential to successful implementation of a design
- describe the role mathematics plays in the analysis of a design

Process/Skill Questions

**F 020: Load requirements**

*Definition:* Process should include the following:

- describe how a structure disperses the loads imposed on it
- describe the types of loads that must be analyzed to determine the design of a building, including wind, snow, dead and live loads
- describe how the loads and stresses acting on a structure can be predicted with mathematical formulas
- compare considerations for dead and live loads on a structure
- size structures based on load calculations
- evaluate and adjust a design to accommodate projected loads

Process/Skill Questions

**F 030: Foundations**

*Definition:* Process should include the following:

- discuss how foundation design distributes the weight of a structure
- describe how foundation design is used to prevent excessive settling or movement, including consideration for soil type, soil bearing capacity, drainage, and piers
- describe the relationship of the footing size and shape to the soil conditions
- describe foundation design related to size, rebar size and placement, and compressive strength
- discuss drainage considerations that should be made in the design of a foundation
- modify section details to describe the sizing of foundation components

Process/Skill Questions

**F 040: Columns and beams**

*Definition:* Process should include the following:

- describe the types of bending, shear, compressive, and axial deformation stresses placed on beams and columns
- describe how deflection and deformation can be predicted with mathematical formulas
- describe how a design uses a bracing system to provide stability through the structure's geometry
- describe how stability is provided by the selection of materials, loading, fireproofing, connections, column schedules, and/or sizing of members
- provide strength and size calculations for floor and support members
- describe fireproofing techniques in practice today in the construction industry
- describe connection techniques for building members to provide building stability
- modify section details to describe the sizing of columns and beams

Process/Skill Questions

## **F 050: Roof systems**

*Definition:* Process should include the following:

- explain how truss roof systems are used to span distances without intermediate supports
- describe how truss strength can be predicted with mathematical formulas
- discuss how different architectural styles can be achieved through different uses of materials, types of trusses, load calculations for roof members
- discuss characteristics of different roof styles
- size and design trusses based on load calculations
- design a roof system for a project

Process/Skill Questions

## **DUTY G:**

### **Presentation and Reviews**

#### **Task:**

## **G 010: Critiques and reviews**

*Definition:* Process should include the following:

- describe how the presentation of a project can determine its acceptance and potential for development
- describe how the critique and review of a project or idea from various players can provide opportunities to reflect on expectations and improvement
- describe how presentations and displays of work can effectively promote the implementation of a project
- facilitate the critique and review of work on a project, including self-assessment, peer review, public exhibit, and interviews
- prepare a presentation to defend your design of a project to a review committee
- develop a presentation for a design, including models, prints, renderings, 3D modeling, related notations, and a specifications manual

Process/Skill Questions

## **G 020: Final presentations**

*Definition:* Process should include the following:

- describe various formats and considerations for a presentation to showcase the project design to target groups, including peers, school panel, parents, school board, and other community groups
- present the design of a project for review and recognition using a variety of formats and presentation methods

Process/Skill Questions



**Task Definitions**  
**Engineering Design and Development**

**DUTY A:**

**Introduction to Engineering Design and Development**

**Task:**

**A 010: Justification of course/project**

*Definition:* Process should include the following:

- describe and define the purpose and rationale of the Engineering Design and Development course
- describe and define the skills and knowledge base Engineering Design and Development is designed to present
- describe the characteristics of a successfully completed project based on previously completed projects
- distinguish the differences between the goals of this class and the type of projects done in other classes

Process/Skill Questions

**A 020: Review of expectations**

*Definition:* Process should include the following:

- describe and define the structure for evaluating a research project
- list examples of levels of performance within the grading structure of this course
- create a resume to record academic achievements and extracurricular activities in school
- develop a portfolio of past accomplishments and research projects

Process/Skill Questions

**DUTY B:**

**Elements of Formal Research**

**Task:**

**B 010: Daily research journal**

*Definition:* Process should include the following:

- recognize a need for retaining all relevant information to a research project in one location
- identify information encountered in the research process that belongs in a journal
- design a format for a journal, which is well organized and easy to use
- utilize a journal as the source for returning to any desired previously encountered information

Process/Skill Questions

**B 020: Conventional library resources**

*Definition:* Process should include the following:

- identify reasons to select conventional library resources as a starting point for research
- select appropriate media to obtain the desired information

Process/Skill Questions

**B 030: Using the computer as a research tool**

*Definition:* Process should include the following:

- distinguish relevant from irrelevant Web sites
- manipulate search engines to find specific information
- create strategies for identifying key terms that narrow a search topic
- search online databases for patents, people, businesses, and government and academic information
- correspond by e-mail, including the use of attachments
- differentiate between an e-mail address and a Web address

Process/Skill Questions

**B 040: Contacting the experts**

*Definition:* Process should include the following:

- compose a business letter and a thank you letter
- define the positive characteristics for personal interviewing (e.g., courtesy, professionalism, listening skills, personal hygiene, etc.)
- develop communication skills for conducting a conversation over the phone
- develop communication skills for conducting a face-to-face interview

Process/Skill Questions

**DUTY C:****Guided Research****Task:****C 010: Methods of brainstorming**

*Definition:* Process should include the following:

- use a decision matrix in narrowing a topic of research
- develop and define constraints and specifications for use in a decision matrix
- use a decision matrix to rank alternatives

Process/Skill Questions

**C 020: Research a topic**

*Definition:* Process should include the following:

- discuss and explain key issues and terminology within a research topic area
- narrow the topic focus using a decision matrix
- give an oral presentation

Process/Skill Questions

**C 030: How to write a problem statement**

*Definition:* Process should include the following:

- develop a problem statement based on research
- apply the decision matrix to a problem, justifying a problem statement based on previous research findings and decision matrices

Process/Skill Questions

**C 040: Researching alternative solutions**

*Definition:* Process should include the following:

- generate a list of existing solutions to a research problem
- using decision matrices, evaluate the advantages and disadvantages of present solutions to a research problem

Process/Skill Questions

**C 050: Developing alternative solutions**

*Definition:* Process should include the following:

- following a review of the specifications and constraints identified in a decision matrix, develop a list of alternative solutions to a stated problem

Process/Skill Questions

**C 060: Redefining and justifying alternative solutions**

*Definition:* Process should include the following:

- conduct preliminary patent searches to determine the originality of alternative choices
- conduct research to determine the merit of alternative choices based on current state of the art in the field

Process/Skill Questions

## **C 070: Presentation methods**

*Definition:* Process should include the following:

- identify techniques for delivering formal presentations
- choose an appropriate formal presentation format, and prepare a presentation
- construct and deliver an electronic presentation centered on a topic of research

Process/Skill Questions

## **DUTY D: Independent Research**

### **Task:**

## **D 010: Independent research**

*Definition:* Process should include the following:

- define and demonstrate time-management planning skills as they pertain to a project
- identify methods and sources for obtaining materials and supplies
- complete an independent research project

Process/Skill Questions

## **D 020: Developing a prototype**

*Definition:* Process should include the following:

- provide a detailed set of instructions for producing a testable prototype based upon research and information gained through research
- create and justify a process for testing a prototype design that will yield valid data concerning the design's attempt at solving a problem statement
- review testing procedures to determine the validity of the testing procedures
- apply the appropriate statistical analysis tools to test results to ensure validity and significance
- identify, define, and implement needed modifications to a design based on ongoing research
- evaluate and explain the effectiveness of a design at solving a problem that has been defined

Process/Skill Questions

## **D 030: Research paper**

*Definition:* Process should include the following:

- arrange data and information compiled throughout a project
- compose a technical research paper, using a standardized format

Process/Skill Questions

<b>DUTY E:</b>
<b>Formal Presentation</b>
<b>Task:</b>
<b>E 010: Formal presentations</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• discuss project findings in a formal presentation before an audience</li> </ul> Process/Skill Questions

# General Safety

## Task Definitions

<b>DUTY : GS (General Safety)</b> <b>General Safety Practices</b>
<b>Task:</b>
<b>GS001: Follow personal safety guidelines</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• identify and comply with personal safety guidelines</li> <li>• demonstrate understanding of clothing safety guidelines and regulations (hard hat, hard-soled shoes, eye protection, long trousers, shirt with sleeves)</li> <li>• describe the impact of positive and negative behavior on personal safety</li> <li>• identify hazards of wearing jewelry while working with tools and equipment</li> </ul> <i>Process/Skill Questions:</i> <ul style="list-style-type: none"> <li>• What is the purpose for features of various safety clothing and other safety items?</li> <li>• What are the steps to identify, report, and correct an unsafe working condition?</li> <li>• What hazards exist for a person wearing jewelry while working in the laboratory?</li> </ul>
<b>GS002: Utilize tools and equipment safely</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• identify and use safe working practices for common hand tools found in the industry</li> <li>• identify and use safe working practices for equipment and power tools found in the industry</li> <li>• explain and demonstrate safe working practices related to electrical hazards, including lockout/tagout procedures for inoperable tools and equipment</li> <li>• inspect hand and power tools to ensure proper working condition</li> <li>• clean and store tools in an organized manner</li> <li>• demonstrate the safe use of ladders</li> <li>• describe the use of fall-arrest systems</li> </ul> <i>Process/Skill Questions:</i> <ul style="list-style-type: none"> <li>• What injuries may occur if a tool is used improperly?</li> <li>• What items or conditions should be checked to ensure a ladder is set up properly?</li> <li>• What conditions will cause a tool or piece of equipment to be unsafe?</li> </ul>

**GS003: Comply with fire and hazardous material guidelines**

*Definition:* Process should include the following:

- identify fire hazards and methods for fire prevention
- identify procedures for fire reporting
- describe methods to extinguish fires
- identify appropriate handling of hazardous material information
- describe appropriate techniques for handling and/or disposing of hazardous materials
- demonstrate appropriate measures when handling hazardous materials
- describe information contained on Material Safety Data Sheets (MSDS)
- Locate and interpret Material Safety Data Sheets

Process/Skill Questions:

- What is the procedure for obtaining information for handling a hazardous material?
- Outline the steps to report a fire within the laboratory area.

**GS004: Report injuries**

*Definition:* Process should include the following:

- describe immediate oral reporting of an injury to a supervisor
- describe procedures to report an accident/injury to students or instructor
- describe procedure for a written report of an injury, including date, extent of injury, and circumstances

Process/Skill Questions

- What are the necessary steps to report an accident or injury?
- Who should be contacted first in the case of an accident?

**GS005: Inspect the workplace for safe working environment**

*Definition:* Process should include the following:

- inspect ladders, scaffolding, etc., for unstable or improperly erected conditions
- identify location of electrocution hazards in the workplace
- describe procedures for removal of job/worksites debris
- describe conditions for properly storing materials
- identify methods to correct hazardous conditions
- describe proper methods of storing materials
- identify air quality hazards

Process/Skill Questions

- What conditions cause a ladder to be unsafe?
- What hazards can be caused by worksite debris?

**GS006: Report unsafe personal, environmental, and equipment safety hazards**

*Definition:* Process should include the following:

- provide oral safety statements based on observation
- document hazards, including date, time, location, and people involved
- submit a written safety report to supervisor

Process/Skill Questions

- What is the procedure for oral reporting of a hazardous condition?
- What type of hazards are possible in the laboratory area?

**GS007: Participate in safety training programs**

*Definition:* Process should include the following:

- participate in safety training sessions
- demonstrate knowledge and skills gained from program topics

Process/Skill Questions

- What safety equipment and materials are located in the laboratory area?
- What safety information will help you the most in avoiding injury in the laboratory area?

**GS008: Practice safe lifting and carrying procedures**

*Definition:* Process should include the following:

- describe safe lifting and carrying procedures
- identify possible injury resulting from improper lifting and carrying techniques
- demonstrate safe lifting and carrying techniques

Process/Skill Questions

- What injuries are most likely to occur from improper lifting of a heavy object?
- What weight is considered the heaviest that should be lifted with the arms and legs?



# SkillsUSA/HOSA

<b>DUTY A: Self-improvement</b>
<b>Task:</b>
<b>A001: Complete a self-assessment and identify individual learning styles</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Identify and list individual strengths</li> <li>• Identify and list areas in need of improvement</li> </ul> Process/Skill Questions
<b>A002: Discover self-motivation techniques and establish short-term goals</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Develop a list of short-term goals</li> <li>• Discuss ways to change or improve lifestyle appearance and behavior</li> </ul> Process/Skill Questions
<b>A003: Determine individual time-management skills</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Prepare and keep a time journal</li> <li>• Discuss ways to improve time-management skills</li> </ul> Process/Skill Questions
<b>A004: Define future occupations</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Search the Internet for career opportunities within specified fields of study</li> <li>• Prepare a presentation on a specified career area</li> </ul> Process/Skill Questions
<b>A005: Develop an awareness of cultural diversity and equity issues</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Research a tradition modeled by the individual's family</li> <li>• Develop personal philosophy statements regarding gender equity</li> </ul> Process/Skill Questions

**A006: Define the customer**

*Definition:* Process should include the following:

- Differentiate between external and internal customers
- Discuss factors that contribute to poor customer relationships

Process/Skill Questions

**A007: Recognize the benefits of doing a community service project**

*Definition:* Process should include the following:

- Discuss and list ways to become involved in the community
- Develop a community service project

Process/Skill Questions

**A008: Demonstrate effective communication with others**

*Definition:* Process should include the following:

- Identify and list personal barriers to listening
- Develop a personal plan to overcome barriers to listening

Process/Skill Questions

**A009: Participate in a shadowing activity**

*Definition:* Process should include the following:

- Summarize the experience of the job shadowing activity

Process/Skill Questions

**A010: Identify the components of an employment portfolio**

*Definition:* Process should include the following:

- Identify the parts of a portfolio
- Design a personal employment portfolio

Process/Skill Questions

**A011: List proficiency in program competencies**

*Definition:* Process should include the following:

- Complete an interpersonal competency assessment

Process/Skill Questions

<b>DUTY B:</b> <b>Civic, Social, and Business Awareness</b>
<b>Task:</b>
<b>B001: Measure/modify short-term goals</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Discuss steps to pursue short-term goal(s)</li> </ul> Process/Skill Questions
<b>B002: Identify stress sources</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• List personal sources of stress</li> <li>• Discuss techniques to cope with individual sources of stress</li> </ul> Process/Skill Questions
<b>B003: Select characteristics of a positive image</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Discuss actions and traits that lead to a positive image</li> <li>• Discuss actions and traits that lead to a negative image</li> </ul> Process/Skill Questions
<b>B004: Demonstrate awareness of government, professional organizations, and trade unions</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Identify the state governor, legislators, and senators</li> <li>• Identify professional organizations pertaining to specific career areas</li> </ul> Process/Skill Questions
<b>B005: Apply team skills to a group project</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Form a team to develop a class project</li> </ul> Process/Skill Questions
<b>B006: Observe and critique a meeting</b>  <i>Definition:</i> Process should include the following: <ul style="list-style-type: none"> <li>• Attend a formal meeting held within the community</li> <li>• Critique the attended meeting</li> </ul> Process/Skill Questions

**B007: Demonstrate business meeting skills**

*Definition:* Process should include the following:

- List and discuss the basic rules to ensure an orderly and business-like meeting
- Role-play appropriate meeting skills

Process/Skill Questions

**B008: Demonstrate social etiquette**

*Definition:* Process should include the following:

- Role-play appropriate social behavior
- Differentiate between good and bad manners

Process/Skill Questions

**B009: Complete survey for employment opportunities**

*Definition:* Process should include the following:

- Gather information on a particular employment opportunity of interest
- Conduct an Internet search of a specific career area

Process/Skill Questions

**B010: Review a professional journal and develop a 3- to 5-minute presentation**

*Definition:* Process should include the following:

- Develop a presentation on the content, purpose, and distribution of a particular professional journal

Process/Skill Questions

**B011: Identify customer expectations**

*Definition:* Process should include the following:

- List and discuss customer expectations
- Discuss the consequences of unmet customer expectations

Process/Skill Questions

**B012: Complete a job application**

*Definition:* Process should include the following:

- Obtain a job application from various businesses in the community
- Conduct a mock job interview

Process/Skill Questions

**B013: Identify a mentor**

*Definition:* Process should include the following:

- Define mentor
- Discuss ways in which a mentor can help an individual meet career goals

Process/Skill Questions

**B014: Assemble your employment portfolio**

*Definition:* Process should include the following:

- Develop an employment portfolio

Process/Skill Questions

**B015: Explore supervisory and management roles in an organization**

*Definition:* Process should include the following:

- Examine an organizational chart
- Discuss the responsibilities of managers and supervisors

Process/Skill Questions

**B016: Recognize safety issues**

*Definition:* Process should include the following:

- Discuss the safety issues within a given career area

Process/Skill Questions

**B017: Evaluate your proficiency in program competencies**

*Definition:* Process should include the following:

- Define task and competency
- List competencies associated with a specified career area

Process/Skill Questions

# Curriculum Frameworks

## Purpose

This section of the framework contains material to help instructors in technical and professional programs reinforce basic skills in the areas of Reading and Writing, Mathematics, and Science. The technical portion of this guide takes a more direct approach by using specific duty and task listings, but changes in the academic section lead in a more general direction. The reason for this is simple: All good instructors do not teach in the same way. However, all good instructors share the trait of being able to connect their material to everyday life. For example, understanding concepts related to heat are important for cosmetology students as well as lathe operators in manufacturing plants. However, each program will probably take a different approach in the amount of detail and examples relating to heat concepts. Both groups require basic science knowledge of principles relating to heat, but the application of the principles will be different.

## Basic Skills: The Content Areas

Included in this guide are materials to support basic skills in Reading and Writing, Mathematics, and Science. The overall approach taken here is a move toward problem-solving skills. By problem solving, we mean the ability to take information and use it for a purpose: to take action, make decisions, predict outcomes, suggest improvements. Another term for these thinking skills is a general “literacy.”

Literacy skills always have been in demand in the workplace. A quick review of workplace training programs and other literature regarding adult education demonstrates that the need for a literate workforce is still one of the most pressing problems employers face today. Indeed, many employers (from small- and medium-sized businesses to Fortune 500 companies) have spent hundreds of millions of dollars on in-house basic skills training programs.

What constitutes a literate workforce? There are many definitions for literacy and hundreds of tests that measure it, but when employers are asked what they’re looking for in potential new hires, the answers are general: They want individuals who can read and write; show up on time;

think and solve problems; and keep their personal lives in order (that is, don't bring a drinking problem into the workplace).

Viewed in this way, the words “literacy” and “literate” are good terms for what educators are trying to instill in their students, the future workforce. The more common definition (being able to read and write) is certainly appropriate, but the additional definitions (knowledgeable, educated, and well-informed) are also apt. It is this broad term, “literate,” that we use to guide instructors on what to cover in the classroom. No matter which Career and Technical Education area is being focused on, no matter how technical the terminology is, instructors are given the task of helping students take information, break it down into necessary parts, process details, and be able to come away with an understanding of some sort. This is “literacy,” and the process is the same for every subject area--teaching students how to think and solve problems.

## **Format**

Each section includes a two-column table. Skills are listed on the left side; suggestions for implementing these skills into the curriculum are listed on the right side. Each suggestion is written in such a way that it can be tailored to most Career and Technical Education programs.

## **Using the Guide**

This guide was prepared with four concepts in mind:

- The instructor is *aware of the need* for students to improve their basic skills.
- The instructor is the *best-qualified person* to decide how to include this material in the classroom or lab. The students' abilities and needs should drive the instructor in deciding how to use, expand, or modify these topics.
- The instructor *already has curriculum that works* for his or her students. Therefore, the suggestions for reinforcing basic skills
  - must be easy to implement.
  - must stand alone.
  - do not need to be taught in a particular order.
  - must be open-ended enough to be useful for any career and technical program.

- ***Time is limited.*** Unless there are quick ways to reinforce basic skills, changes to the curriculum will not be made. Teaching basic skills in the context of technical material will help students make connections that are more memorable and will require no additional lesson planning. Just as instructors incorporate updates in technical knowledge, they can add basic skills concepts as well. Adding a few concepts at a time will help students perform better in the lab as well as on tests and evaluations.

## Methods

The following methods may help instructors decide how to increase basic skill knowledge:

- *Collaborative projects* -- how could a joint project between regular education teachers and vocational instructors reinforce concepts for both programs?
- *Outside assignments* -- would students benefit from an outside assignment explaining how a basic math (science, reading) concept ties to a process in the lab?
- *Extra credit* -- students needing extra credit can research outside topics and turn in a short summary of material.
- *“Need-to-know” assignments* -- students prepare a bulleted list of the basic concepts in science they need to know to correctly perform \_\_\_\_ operation in the lab.
- *Question of the day* -- a few daily math problems for students to answer at the beginning of class allow the instructor to set the tone for the material. This method also gives students an immediate goal when they enter the classroom and teaches them to stay on task. Bonus points may be awarded at the end of the week, quarter, semester, etc.
- *Two-minute oral presentations* -- students who need to practice speaking skills can be asked to give a two-minute oral presentation at the end of class summarizing the main points for the day. Or, a two-minute presentation at the beginning of class can recap the material from a previous class.
- *Connecting with workers* -- students can poll parents, friends, area employers, or other people to find out the top five basic science skills needed on the job.
- *Direct questioning* -- include a few basic knowledge questions in a presentation. Award points to groups based on correct answers.



## Resources

In creating the Academic Reinforcement material for the technical and professional frameworks, we used a number of source documents and resources.

- The English Language Arts, Science, and Mathematics components of the *Curriculum Improvement Project* by Dr. Willard Daggett were consulted to ensure that the top-ranked skills in those areas would be reflected in the academic support material. The English Language Arts and Science components have many linkages to the material included here. (The higher-level math skills such as trigonometry were not included in this document.)
- The Workplace Skills Enhancement Program (WSEP) at the University of Arkansas at Little Rock (UALR) has completed many training projects and job profiles for employers in Arkansas and has collected data from this work with Arkansas employers. Our constant contact with workers and employers provides a tremendous amount of data that we use in designing customized training programs and in working on projects such as curriculum frameworks. Also, the staff of WSEP has experience teaching in Arkansas public schools, the U.S. military, and Job Corps.
- Additionally, other groups within UALR (the Labor Education Program, the Institute for Economic Advancement, and the College of Business) provide resources regarding health and safety information, labor unions and their role in the workplace, computer and information technology, and other training and outreach program data.
- The U.S. Department of Labor (DOL) has many online documents and publications that support workers and issues regarding the workplace. (Work by Philippi and Greenan, 1988, on workplace skills was especially helpful.) Visit the Web site at [www.dol.gov](http://www.dol.gov).
- The Occupational Safety and Health Administration (OSHA) provides online and other resources for instructors and professionals. For topics relating to safety and health, visit [www.osha.gov](http://www.osha.gov).
- The Multistate Academic and Vocational Curriculum Consortium (MAVCC) is an organization that develops competency-based curriculum. For more on MAVCC, see [www.mavcc.org](http://www.mavcc.org).

# ACADEMIC STANDARDS FOR READING AND WRITING

## Strategies for Reinforcement in the Career and Technical Education Classroom

**Note:**

**\* indicates industry-related materials, handouts, notes, etc.**

Objective	Classroom Applications to Industry
<p><i>Present</i> <i>Review, and discuss</i> <b>Master the list of skills employers want for the workplace regarding reading and writing</b></p>	<p>Use the list of skills employers want to introduce students to the requirements of the workplace.</p> <p>Depending on students' ability levels, any of the following methods may be used to increase their understanding of the concepts:</p> <ul style="list-style-type: none"> <li>• Discussion</li> <li>• Interviewing parents or other adults in the workplace about the skills required</li> <li>• Interviewing employers about the skills in terms of importance</li> <li>• Identifying workplace situations in which certain skills become more important than others</li> <li>• Researching adult education programs to learn why deficits in these areas must be remediated and the cost spent yearly on these programs</li> <li>• Researching the topic of adult literacy</li> </ul>
<p><i>Answer</i> <b>simple comprehension or recall questions from a lecture or from written material</b></p>	<p>Provide two examples of workplace materials* on students' reading level.</p> <p>With the first, allow students to read information and then answer brief recall questions. With the second example, read aloud the material but do not give a handout. Ask brief recall questions.</p> <p>Compare the differences. How do students retain information better—orally or</p>

	visually? Discuss learning styles and impact on the job.
<i>Follow, give</i> <b>oral instructions</b>	Using instructions for a hands-on task, have students give <u>oral</u> instructions to a partner or group. Rate the effectiveness of the speaker.
<i>Follow, give</i> <b>written instructions</b>	Using a short list of instructions for a hands-on task, have students give <u>written</u> instructions to a partner or group. Rate the effectiveness of the speaker.
<i>Show</i> <b>the difference between relevant and irrelevant details</b>	Using a copy of workplace materials*, students underline relevant or important details in red, irrelevant or less important details in blue.
<i>Sort</i> <b>objects based on x number of criteria</b>	Using workplace materials*, sort a group of objects based on characteristics identified by instructor (e.g., by color, shape, defect, or a combination of these).
<i>Recognize, identify</i> <b>technical vocabulary</b>	<p>Using workplace materials*, highlight technical vocabulary terms.</p> <p>Create a class dictionary of industry-related technical vocabulary. Students may add illustrations or diagrams. Each student receives a copy of the final product. Emphasize skills such as alphabetical order, guidewords, prefixes, suffixes, and pronunciation guides.</p>
<i>Read</i> <b>aloud</b>	Read aloud from workplace materials* in groups or individually.
<i>Identify, explain</i> <b>symbols, abbreviations, and acronyms relevant to subject area</b>	<p>Using workplace materials*, highlight symbols, abbreviations, and acronyms.</p> <p>Create a table with one column for each: symbols, abbreviations, acronyms. Classify each one and write in the meaning.</p>
<i>Understand, use</i> <b>rules of grammar, usage, spelling, punctuation</b>	Identify the missing punctuation marks, misspelled words, and incorrect use of

	<p>grammar from workplace materials*.</p> <p>Correct the mistakes.</p>
<i>Discuss</i> <b><u>uses and purposes</u> of a variety of workplace communication tools</b>	Find examples of a business letter, memo, report, brochure, proposal, schematic, map, and diagram.
<i>Duplicate</i> <b>process demo by instructor</b>	Using a workplace process, demonstrate steps to complete and have students perform individually or in groups.
<i>Notice, apply</i> <b>word analysis techniques</b>	Using workplace materials*, identify prefixes, suffixes, or roots that indicate meaning (e.g. therma = heat). <sup>1</sup>
<i>Match</i> <b>parts from photographs or diagrams to actual objects</b>	Using workplace materials*, follow a sequence of pictures or diagrams to build, create, or copy an item or process.
<i>Read</i> <b>for main ideas and details</b>	Use a graphic organizer <sup>1</sup> to show main ideas and supporting details.
<i>Distinguish</i> <b>between fact, opinion, and inference</b>	Collect examples of materials based on fact or opinion/inference. Ask students to underline key terms that indicate the presence of facts or opinions.
<i>Distinguish</i> <b>between rows and columns</b>	Using charts or tables from workplace materials*, discuss the reasons for this format.
<i>Identify</i> <b>a cell as a block where a row and column intersect</b>	Identify the quantity in a particular cell.
<i>Select, use</i> <b>appropriate resources and reference tools</b>	<p>Explain the uses for the following: dictionary, thesaurus, almanac, atlas, card catalog, encyclopedia.</p> <p>List reasons for choosing one reference tool over another.</p> <p>Use reference tools to answer questions related to industry or current events.</p>
<i>Paraphrase</i> <b>written or oral material into summary form</b>	Using workplace materials*, determine the best way to condense or shorten the

	<p>material so as to give an overview to a layperson.</p> <p>Using a set of guidelines appropriate to students' level in length and detail, summarize the information into bullet points.</p>
<i>Interpret, fill out/complete</i> <b>forms and records</b>	<p>Using workplace materials*, answer basic questions (e.g., summarize the list of parts from an inventory).</p> <p>Using blank forms or documents, fill in details. Pay close attention to directions. Students critique work with a partner.</p> <p>Create a form or document to be used in a workplace process.</p>
<i>Use, develop a process for remembering</i> <b>details</b>	<p>Use pneumatic devices to organize and remember details. Pneumatic devices<sup>1</sup> include Semantic Maps, Thought Webs, and other creative tools to organize thinking.</p>
<i>Proofread, correct</i> <b>mistakes in written drafts</b>	<p>Using a newspaper article, locate and mark mistakes in grammar, punctuation, or usage.</p> <p>Correct mistakes in written drafts.</p>
<i>Examine different types of writing used in the workplace (reports, memos, brochures, logs, blueprints, formulas, etc.)</i>	<p>Gather samples of workplace materials*. Identify each by type.</p> <p>Compare and contrast the difference between:</p> <ul style="list-style-type: none"> <li>audience (who the document is written for),</li> <li>length,</li> <li>background information/education needed to understand material,</li> <li>level of detail,</li> <li>organization and layout of the document.</li> </ul>
<i>Understand</i> <b>the writing process</b>	<p>In order to apply the writing process, create a workplace communication tool to be used for a specific purpose.</p>

	<p>Prewrite: Brainstorm, gather facts, or do research to create a <u>business letter, memo, report, brochure, proposal, schematic, map, or diagram</u>.</p> <p>Identify the audience.</p> <p>Determine the purpose of the document.</p> <p>Write: Create a first draft.</p> <p>Revise and Edit: Make changes to ensure accuracy.</p> <p>Look at the writing from a different point of view.</p> <p>Shorten or make more concise where possible.</p> <p>Use white space, bold print, and other formatting details to make the document easy to read.</p> <p>Publish: Decide on the best format for the final copy (size, type of material, layout, graphics, etc.)</p> <p>Publish the final draft.</p>
<i>Identify, create</i> <b>sentences of different types</b>	<p>Using workplace materials*, find sentences of varying types. Examples include simple sentences (subject + predicate) and complex sentences (subject + predicate including clauses).</p> <p>Write sentences, paragraphs, or essays using sentences of different types (e.g., write a two-paragraph summary of today's lesson).</p>
<i>Identify, use</i> <b>contractions correctly</b>	<p>Using workplace materials*, locate contractions (e.g., isn't, I'll).</p>

	<p>Identify misuses of contractions.</p> <p>Write a short list of directions relating to an industry process, and use as many contractions as possible.</p>
<p><i>Identify, use correctly</i> <b>commonly misspelled words</b></p>	<p>Using a list of commonly misspelled words<sup>1</sup>, locate errors in the media (newspaper articles, Internet sites, magazines).</p> <p>Ask each student to identify his/her problem words from the list.</p> <p>Attempt to incorporate problem words into class activities (e.g., add them to a list of work instructions).</p> <p>Give short weekly quizzes focusing on five words per week. Award bonus points.</p>
<p><i>Identify, use correctly</i> <b>the English irregular verbs</b></p>	<p>From a list of irregular verbs, review the uses of each.</p> <p>Ask each student to identify his/her problem irregular verbs from the list.</p> <p>Attempt to incorporate problem verbs into class activities, such as making a collection of mistakes from print sources.</p>
<p><i>Identify, use</i> <b>signal words and other cues to improve writing</b></p>	<p>Use a list of signal words<sup>1</sup> and discuss their purpose in writing (signal words are words that raise a flag to a reader to pay attention). Examples --</p> <p style="padding-left: 40px;">Signal words showing emphasis: Most of all, It should be noted, Of course</p> <p style="padding-left: 40px;">Signal words showing a conclusion: Lastly, In summary, Finally</p> <p>Identify common signal words in workplace writing, especially in sequenced lists.</p> <p>Write a list of work instructions using signal words.</p>

<i>Identify components of workplace documents such as blueprints, schematics, floor plans, and other industry-related documents</i>	Label the parts of a workplace document.
<i>Place steps in proper sequence</i>	Using a list of steps or pictures, cut them apart so students can place them in the proper order.
<i>Analyze cause and effect</i>	Experiment with cause and effect in the classroom (e.g., change the sequence of events in a process).
<i>Determine missing information</i>	<p>Locate the information that is missing from a problem, and explain why the problem cannot be solved without it.</p> <p>To reinforce concepts, use a completed problem and remove the important details. Ask students if they can identify what's missing.</p>
<i>Differentiate between tools used for a job</i>	Given a list of tools and a list of functions, identify the most efficient tool for each task.
<i>Assemble or disassemble objects</i>	<p>From a list of oral or written instructions, assemble an object or complete a process.</p> <p>Have students write the instructions for disassembly.</p>
<i>Cross-reference materials to compare information</i>	Using more than one source document, compare the information given.
<i>Interpret reasoning behind rules or regulations</i>	Using workplace materials*, make a list of possible reasons or justifications for a safety guideline, regulation, etc.
<i>Show contrasts between approaches</i>	<p>Given a workplace scenario, write a brief approach to solving the problem. (Working in groups would be beneficial.)</p> <p>Compare and contrast each approach from the perspective of a worker, manager, supervisor.</p>



<i>Organize data in a new format</i>	Using workplace materials*, organize the information into a new format.
<i>Prove a rule or method's sufficiency</i>	Perform an experiment to determine how much tolerance is acceptable in a case study (e.g., find the range of drops of red dye sufficient to match the standard red color used in latex paint).
<i>Show relationships between two or more systems</i>	Using two or more partners related to industry, show or explain how they are interrelated (e.g., explain the relationship between social workers and hospitals).
<b>Given examples of emergency situations, identify a real-world course of action</b>	Using an emergency situation common to your industry, outline a step-by-step plan for action.
<i>Identify variables that affect the outcome of a process</i>	Experiment with or predict variables that affect the outcomes for a process (e.g., weather patterns that adversely affect a process, such as building a road).
<i>Infer situations that meet guidelines when complete information is not available</i>	<p>Given a policy or industry standard that has debatable interpretations, list possible situations that can arise that do not have clear solutions in the policy.</p> <p>Discuss or debate the issues.</p>
<i>Compare finished products to a set of guidelines</i>	<p>Compare a set of objects to a set of guidelines (e.g., analyze a batch of parts and document how they do or do not meet a set of Quality Assurance guidelines).</p> <p>List any discrepancies (parts that do not meet guidelines) and categorize them by type (e.g., burns, holes, etc).</p>
<i>Identify preventive measures for maintenance of a system</i>	List the needed routine maintenance to keep a system working properly.
<i>Predict new standards or rules that may become necessary in the future</i>	<p>Identify recent areas of change or development in your industry.</p> <p>Discuss potential future needs or</p>

	developments that may occur (e.g., potential need for better training requirements for airport personnel).
<b><i>Improve a process by streamlining (locating waste) or decreasing lost time</i></b>	Examine a process in industry in step-by-step detail. Suggest ways to decrease time needed or make the process more efficient.  Isolate the cause of failure in a process by performing an experiment.
<b><i>Prepare a model explaining a concept</i></b>	Build, draw, or create a model that explains a concept (e.g., show a need for environmental standards for water or air pollution).

<sup>1</sup> Fry, Edward; Kress, Jacqueline; Fountoukidis, Dona. *Reading Teacher's Book of Lists*, 4<sup>th</sup> ed. ISBN 0-13-028185-9.

# ACADEMIC STANDARDS FOR MATHEMATICS

## Strategies for Reinforcement in the Career and Technical Education Classroom

### Note:

\* indicates industry-related materials, handouts, notes, etc.

Topics Listing  
Problem Solving  
Operations and Calculations  
Applications  
Data Analysis and Display

### Objectives

### Classroom Applications to Industry

<p><i>Present</i> <i>Review and discuss</i> <b>Master the list of skills employers want for the workplace regarding mathematics</b></p>	<p>Use the list of skills employers want to introduce students to the requirements of the workplace.</p> <p>Depending on students' ability levels, any of the following methods may be used to increase their understanding of the concepts:</p> <ul style="list-style-type: none"> <li>• Discussion</li> <li>• Interviewing parents or other adults in the workplace about the skills required</li> <li>• Interviewing employers about the skills in terms of importance</li> <li>• Identifying workplace situations in which certain skills become more important than others</li> <li>• Researching adult education programs to learn why deficits in these areas must be remediated and the cost spent yearly on these programs</li> <li>• Researching the topic of adult literacy</li> </ul>
PROBLEM SOLVING	
<p><i>Examine, apply</i> <b>problem-solving process</b></p>	<p>Define the problem What is being asked?</p> <p>Decide on a type of solution. Multi-step or single-step question?</p>

	<p>Try any of these:</p> <ul style="list-style-type: none"> <li>Estimate an answer</li> <li>Draw a diagram</li> <li>Find a pattern</li> <li>Guess and check</li> <li>Logical reasoning</li> <li>Make a graph</li> <li>Make an organized list</li> <li>Make a table</li> <li>Solve a simpler problem</li> <li>Use a simulation</li> <li>Work backwards</li> <li>Write an equation</li> </ul> <p>Locate information you need. Do you have all the components?</p> <p>Get missing information. You may need to perform some other calculations</p> <p>Calculate. Look at the answer. How should the remainder be expressed?</p> <p>Check the solution. Is it reasonable?</p>
<b>OPERATIONS AND CALCULATIONS</b>	
<i>Read, write and count numbers</i>	<p>Read and write numbers (especially focus on very large and very small numbers where mistakes are common).</p> <p>Give a weekly quiz asking students to compare and sequence numbers.</p> <p>Example: 0.4445 ____ 0.4455    &gt; or &lt;</p> <p>Put these in order from smallest to largest: 0.66, 0.677, 0.67</p>
<i>Round numbers</i>	<p>Discuss your industry's use of decimals.</p> <p>Identify the place values needed to adequately</p>

	<p>perform a job. For example, a Quality Assurance Technician who works on the line in a manufacturing plant may need to use numbers through the ten-thousandths decimal place.</p> <p>Take a series of sample measurements, and round them to the nearest decimal place identified by the instructor.</p>
<i>Estimate numbers</i>	<p>The skill of making close estimations is tied to understanding accuracy. Discuss real-life situations in which estimation is used.</p> <p>Discuss the practice of estimation before calculation. Regular practice in estimating before calculating will teach students where they make errors and will increase their estimation skills.</p> <p>Discuss work situations in which estimation skills are required and possible consequences of making estimation errors. For example, is an estimate appropriate for inventory purposes? For ordering supplies?</p>
<i>Compute averages</i>	<p>Discuss averages in general terms. Calculate the average temperature, average rainfall or precipitation, average number of students per class, and other relevant examples.</p> <p>Using workplace materials*, calculate a series of averages.</p> <p>For example:</p> <ul style="list-style-type: none"> <li>• Take 10 different measurements of a piece of pipe using a micrometer.</li> <li>• Compare the measurements.</li> <li>• Find the average of all the measurements.</li> <li>• Compare the average to the smallest and largest measurement.</li> <li>• Discuss the effects on quality. When is an average an acceptable benchmark measurement?</li> </ul>

<b><i>Calculate with whole numbers; perform one-step problems with basic operations</i></b>	Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles of addition, subtraction, multiplication, and division.
<b><i>Perform problems that require an understanding of the order of operations</i></b>	<p>Using workplace materials*, make a list of situations or problems that need more than one step to perform them.</p> <p>If the procedures (add, subtract, multiply, divide, etc.) are on the same level of importance, such as adding or subtracting, then the order of operations will not impact the way the problem is solved.</p> <p>If a problem requires more than one level of operation to solve (example, dividing and adding), work the problem correctly by performing the division part first and then the addition.</p> <p>Rework the problem using addition first. Compare the answers.</p> <p>Discuss the importance of reasoning skills to verify that an answer makes sense.</p>
<b><i>Understand the relationship between decimals, fractions, and percentages</i></b>	Make a table comparing fractions, decimals, and percentages.
<b><i>Compute with fractions, decimals, and percentages, and show an understanding of the relationship between them</i></b>	<p>Create sample problems using fractions that relate to everyday situations.</p> <ul style="list-style-type: none"> <li>▪ Poll the class on interesting topics (favorite food). Convert whole numbers to fractions. Votes:  Pizza- 10  Salad- 2  BBQ- 8</li> </ul> <p><math>10+2+8 = 20</math> (recognize denominator value)</p> <p><math>\frac{10}{20}</math> Pizza   <math>\frac{2}{20}</math> Salad   <math>\frac{8}{20}</math> BBQ</p>

	<ul style="list-style-type: none"> <li>▪ Add the fractions.  <math display="block">\frac{10}{20} + \frac{2}{20} + \frac{8}{20} = \frac{20}{20}</math> </li> <li>▪ Convert the fractions to a whole number. (Total answer equals one class' worth of answers.)  <math display="block">\frac{10}{20} + \frac{2}{20} + \frac{8}{20} = \frac{20}{20} = 1</math> </li> <li>▪ Convert the fractions to percentages.  <math display="block">\frac{10}{20}</math> means 10 divided by 20 = 0.50  0.50 = 50%   Move the decimal two places to the right.  0.50 = 50%   <math display="block">\frac{2}{20}</math> means 2 divided by 20 = 0.10  0.10 = 10%   <math display="block">\frac{8}{20}</math> means 8 divided by 20 = 0.40  0.40 = 40%   50% + 10% + 40% = 100%  Notice the totals add to 100%.   So, <math>\frac{20}{20} = 1 = 100\%</math> </li> </ul> <p>Using workplace materials*, calculate work-related questions using fractions, decimals, and percentages.</p> <p>Calculate shipping costs for Internet purchases (such as music from amazon.com).</p>
<i>Solve formulas and equations</i>	<p>Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles of equations.</p> <ul style="list-style-type: none"> <li>▪ Work left to right</li> <li>▪ Use order of operations</li> <li>▪ Place numbers on one side, variables on the other side</li> </ul>

<i>Obtain squares and square roots</i>	<p>Review the methods for calculating squares, square roots, cubes, and cube roots. Use industry-related formulas to demonstrate examples.</p> <p>Compare the difference between the two common answers to 32 (answer = 9, not 6). How would an incorrect value affect the work on the job?</p>
<i>Convert units of measure: Recognize components of measuring systems (U.S. and metric) for length</i>	Discuss industry measures and terms relating to length.
<i>Convert units of measure: Recognize components of measuring systems (U.S. and metric) for mass/weight</i>	Discuss industry measures and terms relating to mass/weight.
<i>Convert units of measure: Recognize components of measuring systems (U.S. and metric) for volume</i>	Discuss industry measures and terms relating to volume.
<i>Measure with a certain degree of accuracy</i>	<p>Estimate measurements.</p> <p>Using workplace materials* and tools, take measurements of work-related and classroom items.</p> <p>Depending on ability level, students may measure to the nearest foot, inch, centimeter, etc.</p>
<b>APPLICATIONS</b>	
<i>Solve word problems</i>	Help students feel more comfortable with word problems by placing simpler problems in word problem form; or take concepts students have already mastered and ask them to write word problems for each other to solve.
<i>Select/apply mathematical formulas</i>	Review a set of math formulas and then a list of sample problems. Decide which formula(s) apply to each problem.
<i>Understand the importance of time in the workplace</i>	Using workplace materials*, make a list of workplace scenarios that require using time



	correctly, such as keeping a time card or heating a liquid solution for 20 minutes.
<b>Recognize components of time systems (clocks and calendars)</b>	a.m. and p.m. Leap year Military time
<b>Discuss, identify, understand terms relating to measuring time</b>	Discuss the units of time measurement and time vocabulary: second, minute, hour, day, week, month, year, leap year, fiscal year, quarter, annual, biannual, etc.
<b>Understand that time can be expressed in terms of equivalencies</b>	Show the time equivalencies using fractions. For example: $1 \frac{1}{2} \text{ days} = \underline{\hspace{1cm}} \text{ hours}$  $\begin{array}{rcl} 1 \text{ day} & = & 24 \text{ hours} \\ + \frac{1}{2} \text{ day} & = & +12 \text{ hours} \\ \hline 1 \frac{1}{2} \text{ days} & = & 36 \text{ hours} \end{array}$
<b>Compute time conversions</b>	Make a table that shows the equivalencies of time units.  Compute conversion problems at the appropriate level of difficulty. Examples include: <ul style="list-style-type: none"> <li>• Convert minutes to hours</li> <li>• Convert hours to days</li> <li>• Convert seconds to years</li> </ul>
<b>Calculate ratio and proportion</b>	Review fractions when discussing ratio and proportion.  Draw common classroom items to scale by finding a conversion rate (1 foot equals 1 inch).  Make predictions using ratios. (If each student in the class has three children, how many children will there be altogether? Write the ratios.)
<b>Apply geometry principles: Use formulas for measuring shapes of two dimensions</b>	Determine the formulas that apply to two dimensions: perimeter, area, surface area. Find the perimeter of the classroom.

	<p>Discuss the perimeter of objects that are not shaped as perfect squares. How does this change the formula for perimeter?</p> <p>Find the area of the tiles on the floor.</p> <p>Find the area of the classroom.</p> <p>Review that all areas are expressed in terms of square units (square inches, square miles, etc.).</p>
<i>Apply geometry principles: Use formulas for measuring shapes of three dimensions</i>	<p>Review the formulas that apply to three dimensions of objects: volume.</p> <p>Find the volume of common objects such as soda cans, pizza boxes, etc.</p> <p>Review that volume is expressed in cubic units.</p> <p>Discuss industry-specific needs for these formulas. For example, find the volume of a tank or silo.</p>
<i>Define terms relating to money</i>	<p>Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles relating to money.</p> <p>For more advanced students, include terms and principles of economics, finance, or statistics.</p>

<i>Perform one-step problems involving money</i>	Make change. Count up (rather than backwards) to make change.
<i>Perform multiple-step problems using money</i>	Calculate gross and net earnings.  Calculate <ul style="list-style-type: none"> <li>▪ Interest</li> <li>▪ Sales tax</li> <li>▪ Percent off</li> <li>▪ Sale price</li> <li>▪ Profit percentages</li> </ul> Perform banking transactions.
<i>Perform business-related financial activities</i>	At a level of complexity appropriate to your industry and to students' ability levels, solve income/expense problems, prepare budgets, etc.
<i>Use a calculator to perform computations</i>	Identify appropriate activities that can be performed using a calculator (calculators allow students to concentrate on problem-solving strategies).  Award prizes for weekly activities or competitions.
<i>Calculate measurements taken from measuring devices</i>	Add, subtract, multiply, and divide measurement numbers by plugging them into formulas.
<i>Perform/prepare an inventory</i>	Use a sample group of items to prepare an inventory.  Review inventory vocabulary terms.  Discuss the math processes that would apply to the inventory process.
<b>DATA ANALYSIS AND DISPLAY</b>	
<i>Recognize types of visual representations</i>	Charts Graphs Tables

<i>Interpret</i> <b>charts, graphs, and tables</b>	<p>Answer simple questions about charts, graphs and tables.</p> <p><i>Solve</i> multi-step problems involving the correlation of graphs and tables.</p>
<i>Collect/record</i> <b>data</b>	<p>As appropriate to industry, practice sampling methods. Discuss safety precautions for sampling. Visit OSHA at the Department of Labor Web site for more details.</p> <p>Practice collecting and recording sample data from your industry (such as measurements taken using a micrometer). Compare class answers.</p> <p>Find the range of answers (maximum and minimum). Find the average.</p> <p>Discuss an acceptable range of answers (<math>\pm</math>), and graph the results showing the number that fell inside and outside the acceptable range.</p>
<i>Review and apply</i> <b>principles of probability</b>	<p>Use real-life examples that are highly motivating to direct the students' attention to probability principles.</p> <p>(Example, "I am thinking of a number between 1 and 50. The person who guesses the number will receive that many bonus points if s/he can tell me the probability of choosing the number correctly.")</p>
<i>Use</i> <b>probability models to predict chance events</b>	<p>Calculate <u>theoretical probability</u> of an event (e.g., the probability of rolling a 5 on a die is <math>1/6</math>).</p> <p>Find <u>empirical probability</u> of an event by performing repeated experiments. Compare the two probabilities.</p>
<i>Calculate and interpret</i> <b>statistics</b>	<p>Identify the importance of using statistics correctly.</p> <p>Bring examples of statistics from the news or</p>

	<p>media and analyze them: Are they ambiguous? Are they correct? What data is the advertisement trying to get the public to see?</p> <p>For a humorous look at statistics, see <i>How to Lie with Statistics</i> by Huff and Geis.</p>
<i>Interpret</i> <b>plans/blueprints</b>	<p>Review vocabulary and terms for plans, blueprints, and schematics.</p> <p>Build a plan or blueprint one layer at a time, starting with the basic identifying information.</p> <p>Add layers of wax paper or other transparent drawing material on top of the first layer that allows each layer to be viewed individually or the entire drawing as a whole.</p>
<i>Construct</i> <b>charts and tables</b>	<p>Discuss chart types and chart vocabulary.</p> <p>Using workplace or sample data from the class, construct tables and charts.</p> <p>For a daily example, consult <i>USA Today</i> online and look for the snapshots section that shows a graph of some sort. Ask weekly bonus questions about the data.</p> <p>Challenge students to bring in examples of charts and graphs containing errors.</p>

# ACADEMIC STANDARDS FOR SCIENCE

## Strategies for Reinforcement in the Career and Technical Education Classroom

**Note:**

**\* indicates industry-related materials, handouts, notes, etc.**

*Topics Listing*

**General Science:** Topics not specific to a content area

**Physical Science:** Mechanics and Physics  
Energy and Waves  
Thermodynamics  
Electromagnetism  
Chemistry  
Optics

**Life Science:** Cell Biology  
Evolution  
Genetics and Heredity  
Human and Animal Development

**Anatomy:** Ecology  
Viruses  
Bacteria  
Plants

**Earth Science:** Earth in Space  
Solar System/Astronomy  
Atmosphere and Weather  
Oceans and Water  
Earth Resources

**Objective**

**Classroom Applications to Industry**

<b>GENERAL SCIENCE</b>
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<p><i>Present</i>  <i>Review and discuss</i>  <b>Master the list of skills employers want for the workplace regarding science skills</b></p>	<p>Use the list of skills employers want to introduce students to the requirements of the workplace.</p> <p>Depending on students' ability levels, any of the following methods may be used to increase their understanding of the concepts:</p> <ul style="list-style-type: none"> <li>• Discussion</li> <li>• Interviewing parents or other adults in the workplace about the skills required</li> <li>• Interviewing employers about the skills in terms of importance</li> <li>• Identifying workplace situations in which certain skills become more important than others</li> <li>• Researching adult education programs to learn why deficits in these areas must be remediated, and discover the cost to employers to educate adult workers</li> <li>• Researching the topic of adult literacy</li> </ul>
<p><i>Perform</i> <b>computations as required to solve problems</b></p>	<p>Use the metric system to convert units of measure.</p> <p>Round numbers to correct number of significant figures.</p> <p>Determine percentage of error.</p> <p>Understand validity, reliability, accuracy, and precision.</p>
<p><i>Apply</i> <b>scientific method of inquiry</b></p>	<p>Identify the steps of the scientific method.</p> <p>Conduct experiments.</p> <p>Understand the following terminology:          Conclusions vs. inferences          Variables          Replications          Samples/sample size</p>
<p><i>Investigate</i> <b>science history as it applies to industry</b></p>	<p>In groups, research topics in science pertaining to your industry. Have students assign roles for each member of the group.</p> <p>Present findings in report format or in oral presentations.</p>

	<p>Investigate science ethics.</p> <p>Recognize the processes available for accountability in industry. For example, OSHA has a Safety and Health Program Assessment Worksheet whereby employers can be rated for safety issues. See <a href="http://www.osha.gov/SLTC/safetyhealth_ecat/mod3.htm">http://www.osha.gov/SLTC/safetyhealth_ecat/mod3.htm</a></p> <p>[Note: Safety and Health is a mandatory subject of bargaining when a workplace is unionized; in both unionized and non-unionized workplaces, an employer cannot create and dominate workplace safety committees (see the National Labor Relations Act).]</p>
<i>Use scientific instruments to measure aspects of the environment</i>	Gather data on time, length, mass, pressure, volume, acceleration, or other measurables using instruments from the job.
<i>Demonstrate an understanding of data</i>	<p>List the processes involved in gathering data.</p> <p>Suggest ways that data can be grouped or organized.</p> <p>Collect specimens.</p> <p>Show how data can be represented (graphically, charts and diagrams, etc.).</p> <p>Construct a model to depict a basic concept.</p>
<i>Identify the seven basic S I (Systeme International) units</i>	<p>Length: meter, m  Mass: kilogram, kg  Time: second, s  Electric current: ampere, A  Temperature: Kelvin, K  Amount of substance: mole, mol  Luminous intensity: candela, cd</p> <p>For a dictionary of units, see <a href="http://www.ex.ac.uk/cimt/dictunit/dictunit.htm">http://www.ex.ac.uk/cimt/dictunit/dictunit.htm</a></p>
<i>Identify S I (Systeme International) Derived units</i>	Choose units appropriate to your industry (hertz, ohm, volt, watt, etc.).



	Create a picture dictionary demonstrating the concepts.
<i>Review</i> <b>relevant theories, laws, and models</b>	As relating to your industry, discuss important theories, laws, and models.
<i>Use</i> <b>reference tools to solve problems</b>	Use scientific reference tools (such as the Periodic Table of Elements) to learn more about specific industry concepts.
<i>Practice</i> <b>safe lab procedures</b>	Handle equipment with care.  Demonstrate safety and first aid procedures.  Identify harmful substances.
<b>PHYSICAL SCIENCE</b>	
<i>Understand</i> <b>the cyclical nature of systems</b>	Show, demonstrate, model, track the cycles of any of the following systems: Growth and decay Food webs Weather Water
<i>Analyze/classify</i> <b>matter according to type</b>	Identify types of matter (solids, liquids, gases). Which types are predominantly used in your area of industry?
<i>Explain</i> <b>the concepts of work and power</b>	Identify machines used in industry.  Identify how energy levels change when work or power is increased/decreased.  Identify fuel sources used in your industry.  Discuss internal and external combustion.  Create a model demonstrating the uses of levers and pulleys.
<i>Be familiar</i> <b>with concepts of motion</b>	Measure acceleration and deceleration. Understand the relationship between speed and velocity by performing experiments. Recognize waves and vibrations as a type of motion.

	Understand action and reaction. Review laws pertaining to motion.
<i>Understand</i> <b>concepts related to force</b>	<p>Show the need for balance of forces acting on an object.</p> <p>Observe centrifugal and centripetal forces in action.</p> <p>Show how friction is created and must be accounted for in using and preserving equipment.</p> <p>Create a chart showing types of lubricants needed in a factory and schedule of maintenance.</p> <p>Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles of inertia.</p> <p>Show the relationship between pressure, mass, and weight.</p>
<i>Understand and apply</i> <b>principles relating to the atom</b>	<p>Understand that atoms have a positive, negative, or neutral charge. (Classify protons, electrons, and neutrons.)</p> <p>Identify ions.</p>
<i>Investigate</i> <b>forms of and changes in energy</b>	<p>Discuss how energy is measured.</p> <p>Observe changes in energy relationships.</p> <p>Identify catalysts and reactants.</p> <p>Identify sources of kinetic and potential energy in your industry.</p>
<i>Discuss, apply</i> <b>principles of electricity and electric currents</b>	<p>Identify types of circuits and switches.</p> <p>Show the difference between direct and alternating currents. Give examples of the best/most efficient use of each.</p> <p>Determine how electricity is measured, and solve problems using these terms. (Example, use Ohm's</p>

	<p>law to calculate current, resistance, and voltage.)</p> <p>Identify good conductors and insulators, and discuss how to choose them.</p> <p>Understand grounding, and create a visual display of grounding safety practices. Include the threat of static electricity.</p> <p>Show the uses of a vacuum tube by building a model.</p> <p>Compare the following ways of generating electricity:</p> <ul style="list-style-type: none"> <li>Hydroelectricity</li> <li>Motors</li> <li>Solar power</li> <li>Steam/nuclear</li> <li>Transformers</li> <li>Incandescent (light)</li> </ul> <p>Show the implications for your industry.</p> <p>As appropriate to your industry, identify electrochemical energy sources (cells, electrodes, batteries) and the processes of oxidation and reduction.</p>
<i>Be familiar with sound waves</i>	<p>Compare how sound waves travel between liquids, solids, and air.</p> <p>Examine different types (lengths) of sound waves.</p> <p>Examine decibels safe for human hearing.</p> <p>Identify safety precautions for industry regarding sound tolerance.</p> <p>Be able to use correctly the terms below as they relate to your industry. For example, ask students to write a short essay explaining a demonstration from class and include the following terms:</p> <ul style="list-style-type: none"> <li>Amplification</li> <li>Audible range</li> <li>Frequency</li> <li>Acoustics</li> </ul>

	Resonance Speed
<i>Be familiar with principles of heat</i>	<p>Differentiate between the three types of heat transfer (conduction, convection, radiation).</p> <p>Understand that substances expand and contract due to heating and cooling.</p> <p>Identify purpose and types of insulations used.</p> <p>Differentiate between heat and temperature.</p>
<i>Investigate and apply concepts relating to temperature</i>	Use the temperature scales; convert between Celsius and Fahrenheit.
<i>Explain the concepts of magnetism</i>	<p>Understand that currents create magnetic fields.</p> <p>Identify materials that are good conductors and the properties that make them such.</p> <p>Understand electromagnetic forces present in earth.</p>
<i>Investigate/apply chemical properties</i>	<p>Differentiate between acids and bases. Find pH for substances used in industry.</p> <p>Identify substances used in your industry and classify them by type.</p> <p>Name the major drugs, fertilizers, or additives used in your industry.</p> <p>Define and state examples of chemical reactions.</p> <p>Be familiar with solutions used in your industry.</p> <p>Compare saturated and unsaturated solutions.</p> <p>Determine whether a solution is soluble or insoluble.</p> <p>Explain solute and solvent.</p>
<i>Investigate forms of and changes in matter</i>	Compare and contrast physical and chemical changes.

	Discuss the types of physical or chemical changes that take place in your industry from processing raw materials to manufacturing.
<i>Understand and apply concepts relating to the elements</i>	<p>Examine the four elements that make up 99% of living organisms [hydrogen (H), oxygen (O), nitrogen (N), and carbon (C)].</p> <p>Element groups:</p> <ul style="list-style-type: none"> <li>Alkali metals</li> <li>Alkaline earth metals</li> <li>Transition metals</li> <li>Other metals</li> <li>Metalloids</li> <li>Nonmetals</li> <li>Halogens</li> <li>Noble gases</li> <li>Rare earth elements</li> </ul>
<i>Be familiar with principles of light</i>	<p>Discuss light as a form of energy.</p> <p>Describe types of lighting systems.</p> <p>Examine the light spectrum and note the relative smallness of visible light.</p> <p>Define reflection and refraction.</p> <p>Explain how light carries information (by lasers), and show examples of the impact on technology/industry.</p> <p>Identify types of lenses.</p>
<i>Be familiar with principles of color</i>	<p>Diagram the main parts of the eye involved in seeing color (rods, cones).</p> <p>Use prisms to split light into the visible spectrum.</p> <p>Briefly explore color blindness. What precautions should colorblind people take regarding workplace safety?</p> <p>Define situations in which colorblindness impacts a worker's ability to do his/her job.</p>

<b>LIFE SCIENCE</b>	
<i>Explain the presence of cells as the identifier of all living organisms</i>	<p>Examine the cells of organic material used in your industry, using books, the Internet, or a microscope.</p> <p>Recognize that cells divide or replicate to promote growth of an organism.</p> <p>Examine the parts of a cell. Compare the cell to a machine. How do the parts function and rely on each other?</p> <p>Give examples of one-celled and multiple-celled organisms.</p> <p>Review the classification system of all organisms (kingdom, phylum, etc.).</p> <p>Create a circle graph or pie chart (totaling 100%) showing the relationship (in numbers) between the groups of organisms:</p> <ul style="list-style-type: none"> <li>Bacteria</li> <li>Fungi</li> <li>Viruses</li> <li>Insects</li> <li>Plants</li> <li>Vertebrates</li> <li>Invertebrates</li> </ul> <p>Compare some of the cell processes (active and passive transport) with the processes in your industry.</p>
<i>Understand the progress of evolution of organisms</i>	Recognize how a species will adapt to better fit in its environment over time.
<i>Explain the role of genetics in human development</i>	<p>Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles of heredity, including:</p> <ul style="list-style-type: none"> <li>• Half of an individual's genes are contributed by each parent</li> <li>• Traits that are inherited are either dominant or recessive from the parent(s)</li> <li>• Cell division by mitosis vs. meiosis</li> <li>• Disabilities are caused either by</li> </ul>

	genetic/inherited conditions (such as Down's Syndrome) or in accidents occurring after birth, such as brain damage due to a car accident or a stroke
<i>Investigate/apply</i> <b>principles of human development</b>	Describe the life cycle of humans and other animals.  Use the concept of human development to explain the need for understanding foundation skills in your area. (For example, children do not run before they walk.) Use this concept to explain other events that occur in a natural order in your industry.
<i>Explore</i> <b>additional concepts pertaining to humans and other animals</b>	Give examples of ways organisms adapt to their environment.  As relating to industry, review the concepts of: Aging Immune system Skin and Tissues Blood and hemoglobin Disease
<i>Compare/contrast</i> <b>the differences between sexual and asexual reproduction</b>	Determine instances when understanding the concepts of sexual reproduction are important for your industry.  Highlight the effects of unsafe working practices on unborn fetuses or the dangers present for pregnant women working in industry.
<i>Show a general understanding of the</i> <b>importance of health</b>	Explore the cost of lost wages and worker's compensation in the past year due to health problems.  Research the most common health problems among workers (workers with safe jobs; workers with most hazards to health, etc.).
<i>Investigate</i> <b>the food cycle</b>	Identify food chains, food webs, food pyramids. Show how changes to the food cycle affect the environment and humans.

	Name the food groups.
<i>Understand</i> <b>nutrition and the body's need for a diet that provides vitamins and minerals</b>	<p>Show an understanding of body systems (circulatory, nervous, digestive, etc.) as they relate to industry.</p> <p>Identify deficient vitamins and minerals among a particular population (American workers, workers in specific environments, workers who do not go outdoors, or those who always work outdoors) and the health risks associated with job types (office work, mining work, etc.).</p>
<i>Observe</i> <b>health code/sanitation requirements</b>	<p>Research the development of health code and sanitation requirements, including OSHA.</p> <p>Compare/contrast workplaces of 1850, 1900, 1950, and 2000 regarding health and safety.</p> <p>Discuss the most common workplace violations of health requirements and present in a graphic format (e.g., maps, charts).</p> <p>Discuss potential effects of ignoring health requirements.</p> <p>After identifying workplace hazards, create several plans to treat the problem. Debate the benefits of each.</p> <p>To avoid the threat of employers choosing ineffective means of ensuring safety on the job, locate MSDS sheets, first aid stations, personal protective equipment, worker's compensation claims offices/paperwork, etc.</p> <p>Using workplace materials*, locate the section on safety regulations. Ask students to rank the items. Debate the importance of each. Determine the threat of ignoring regulations. Research which regulations are often disregarded.</p> <p>Explore proactive measures students can take to extend their health.</p> <p>Understand the importance of mental health in addition to physical health.</p>



<i>Investigate/apply</i> <b>principles of anatomy and physiology</b>	<p>As relating to your industry, explore issues relating to anatomy and physiology.</p> <p>Study the skeletal system--the bones of the arm, hand, and neck. Research carpal-tunnel syndrome.</p> <p>Identify the types of fractures and those most common to your line of work. Learn how to prevent falls.</p>
<i>Understand</i> <b>basic principles of ecology</b>	<p>Define ecology.</p> <p>Identify five major ways in which people interact with the environment, especially as relating to your industry.</p> <p>Discuss the effectiveness of the media as compared with pro-science groups (such as Greenpeace) on the public's awareness of important environmental issues.</p> <p>Identify any areas of concern regarding waste/waste management in your industry.</p> <p>Show the difference between a niche, community, habitat, and ecosystem.</p> <p>Give examples of herbivores, carnivores, and omnivores. How does your industry use and serve each group?</p> <p>Understand predators' effects on food chains. Identify predators of industry.</p> <p>Explain the process of decomposition and decay. How does industry interfere with or interrupt these processes?</p>
<i>State</i> <b>the differences between viruses and bacteria</b>	<p>Define viruses and bacteria. Explore viral and bacterial threats present in the workplace. How can they be prevented? How can they be treated?</p> <p>State the benefits of viruses and bacteria.</p> <p>Explain the recent increased resistance to drugs and antibiotics.</p>

<i>Understand</i> <b>basic concepts relating to plants</b>	<p>Describe the interchange of oxygen and carbon dioxide between plants. Contrast it with the way humans exchange oxygen and carbon dioxide.</p> <p>As relating to industry, review the concepts of:</p> <ul style="list-style-type: none"> <li>Fertilization</li> <li>Parts of a plant and functions of each</li> <li>Effects of temperature on plants</li> <li>Need for water and light</li> <li>Photosynthesis</li> </ul>
<b>EARTH SCIENCE</b>	
<i>Recognize</i> <b>earth's position in the universe</b>	<p>As relating to your industry, identify relevant topics regarding:</p> <ul style="list-style-type: none"> <li>Asteroids</li> <li>Comets</li> <li>Stars</li> <li>Galaxies</li> </ul> <p>Identify the planets in the solar system. Compare and contrast earth with other planets.</p> <p>Create a model showing the relative size of earth within our solar system. Use mathematical relationships to make sure the scale is correct (earth is the size of ____, so the sun should be the size of ____).</p> <p>How do the phases of the moon and sun affect the hemispheres?</p>
<i>Investigate</i> <b>the history of the earth</b>	<p>Identify geological, chemical, and other methods of determining the age of an object.</p> <p>Demonstrate that fossils and rocks are indicators of previous eras.</p> <p>As a class, create a timeline indicating the age of the earth. Include the various ages (Ice Age, etc.) and the length of each. Make sure the timeline is drawn to scale. Assign each age to a group and research the following:</p> <ul style="list-style-type: none"> <li>Weather</li> <li>Major events at beginning and end of age</li> <li>Organisms living during this time</li> </ul>

	Factors that made the age unique
<i>Investigate</i> <b>physical characteristics of the earth</b>	<p>Label/model the components of the earth.</p> <p>Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles of gravity.</p> <p>Solve problems of longitude, latitude, and time zones.</p> <p>Create a model of the ratio of land and water on earth.</p>
<i>Investigate</i> <b>physical forces acting on the earth</b>	<p>Examine erosion and depletion of nonrenewable resources.</p> <p>Identify natural disasters such as hurricanes and earthquakes. Research the effects of a past disaster on a specific industry.</p> <p>Understand, at a level of complexity appropriate to your industry and to students' ability levels, basic principles of plate tectonics (the earth's surface is broken into large plates; movement of these plates over time causes earthquakes and other geologic activity).</p>
<i>Explain</i> <b>the basic components of earth's rotation</b>	<p>Understand that the earth spins on its axis at an angle of 23 ½ degrees. Identify the period of one complete rotation as a day; longer cycles of rotations identify the seasons.</p> <p>Discuss time zones.</p>
<i>Identify</i> <b>the earth's atmosphere and its components</b>	<p>Identify the main elements in the earth's atmosphere (nitrogen and oxygen).</p> <p>Identify layers of the atmosphere and ozone layer. Explain concepts of air pressure.</p>
<i>Understand</i> <b>basic principles of the solar system</b>	Demonstrate how the sun strikes the earth at different angles depending on location.
<i>Demonstrate</i> <b>the relationship between climate and weather</b>	Identify the factors that create weather.

	<p>Show how landscape features are affected by changes in climate or weather.</p> <p>Identify the greenhouse effect. How does industry contribute to it?</p> <p>Describe the relationship between altitude and weather.</p> <p>Understand that changes in the weather may be seen as fronts that are put in motion by the jet stream.</p> <p>Identify types of precipitation.</p> <p>Differentiate between types of clouds.</p> <p>Understand the effect of winds, wind speeds, and impacts on vegetation.</p>
<i>Learn and apply concepts relating to the oceans</i>	<p>Label the major oceans and seas. Determine the elements in ocean water (nearly all elements are present).</p> <p>Identify or draw the structural components of the ocean floor.</p> <p>Explain the relationship between the moon and the tides.</p> <p>Explore ways the ocean is used for power and business.</p>
<i>Investigate principles of water</i>	<p>Identify the parts of the water cycle and the effects of the processes involved.</p> <p>Define water's chemical properties:  Water is the universal solvent  Water has a neutral pH of 7  Chemically, water is one atom of oxygen bound to two atoms of hydrogen</p> <p>Measure salinity. Which industries rely heavily on water?</p> <p>Define water's physical properties:  Water is the only natural substance that exists</p>

	as solid, liquid, and gas Water's surface has a high density Water has a high tolerance for heat (heat index) Water's weight Water as a coolant Specific gravity
<i>Investigate</i> <b>conservation of physical and natural resources</b>	As relating to your industry, discuss or debate the issues of: Allocation of resources Recovering resources Best/worst methods of using resources  Compare/contrast renewable and nonrenewable resources.  Note the important developments in your industry regarding mineral, soil, water, and wildlife conservation.  Discuss alternative sources of energy as relating to your industry.
<i>Investigate</i> <b>issues regarding scientific technology</b>	As relating to your industry, discuss the uses of technology. What are the newest developments? What effects does the technology have on our society? Political system? Discuss the role of economics on technology.
<i>Apply</i> <b>science principles/laws to environmental issues</b>	Discuss how humankind alters the earth and environment through pollution and the use of resources and technology.

# Arkansas' All Aspects of Industry

## Defining “All Aspects”

All aspects of an industry include, with respect to a particular industry that a student is preparing to enter, planning, management, finance, technical and production skills, underlying principles of technology, labor and community issues, health and safety, and environmental issues related to that industry. Planning is examined at the level of both an individual business and the overall industry. Planning elements might include:

- Developing strategic plans—mission, vision, goals, objectives, and/or a plan of action
- Working with planning tools such as surveys, market research, and competitive analysis
- Anticipating needs for staffing and major purchases of equipment and supplies
- Developing plans for training and upgrading of staff
- Forecasting market trends
- Developing business plans for entrepreneurial ventures

Management addresses methods typically used to manage enterprises over time within the industry as well as methods for expanding and diversifying workers' tasks and broadening worker involvement in decisions. Key elements of management might include:

- Using an organization chart to explain how a corporate chain of command works
- Providing input for strategic plans and communicating the company's vision and mission statements
- Leading employees in carrying out strategic plans and action plans
- Evaluating employee performance
- Anticipating technology and other major purchasing needs
- Ensuring equity and access for employees
- Resolving conflicts
- Developing job descriptions and written policies/procedures
- Identifying recruitment procedures, training opportunities, methods of evaluation, and retention strategies
- Working with professional associations and community outreach efforts

Finance examines ongoing accounting and financial decisions and different methods for raising capital to start or expand enterprises. Finance functions might include:

- Developing budgets
- Preparing financial statements
- Analyzing and managing financial transactions and records
- Implementing payroll procedures
- Determining and paying taxes
- Identifying indirect wage costs (benefits, FICA, insurance, worker's compensation)
- Making loans and granting credit to customers
- Developing graphs and charts related to company finances
- Identifying and implementing methods of sustaining profitability of a business
- Managing 401K plans
- Identifying sources of capital

Technical and production skills cover specific production techniques and alternative methods for organizing the production work, including methods that diversify and rotate workers' jobs.

Technical and production skills that an employee should have to succeed in a business or industry might include:

- Developing and upgrading job-specific skills
- Using troubleshooting and problem-solving techniques
- Analyzing information to make decisions
- Identifying and implementing quality assurance techniques
- Employing communication skills such as writing, listening, speaking, and reading
- Participating in team efforts
- Implementing projects and new techniques
- Demonstrating basic computer skills; employing time-management techniques in completing projects and assigned tasks
- Demonstrating ethical behavior and work ethic

Underlying principles of technology provide an integrated study across the curriculum of the mathematical, scientific, social, and economic principles that underlie the industry's technology.

Principles of technology that an employee should know might be demonstrated by:

- Exhibiting proficiency in mathematical and scientific functions related to new and emerging technologies
- Continuously upgrading job skills needed to implement new technologies
- Participating in industry certification programs
- Cross-training to enhance one's value to the organization and to enhance job promotion opportunities
- Understanding and adhering to ethical issues related to technologies

Labor issues examine worker rights and responsibilities, labor unions and labor history, and methods for expanding workers' roles. Labor issues might include:

- Understanding and implementing worker rights and responsibilities
- Working with labor unions
- Keeping abreast of local, state, and federal legislation affecting employee and employer rights and responsibilities
- Negotiating and settling worker disputes
- Identifying certification requirements for specific jobs
- Analyzing the impact of labor agreements on business operations

Community issues explore the impact of the industry on the community and the community's impact on and involvement with the industry. Concepts of business and community relations might include:

- Developing and working with community outreach projects
- Participating on advisory committees and community organizations
- Working with professional associations
- Developing and implementing public relations plans
- Participating in community service projects



Health, safety, and environmental issues examine these concepts in relation to both the workers and the larger community. Concepts related to health, safety, and the environment might include:

- Identifying and implementing federal, state, and local regulations related to the health and safety of employees
- Understanding and strictly adhering to federal, state, and local environmental regulations related to the business
- Identifying job-specific health hazards and safety issues
- Identifying and implementing basic safety and first aid training techniques for emergencies such as personal illness or injury, tornadoes, fires, nuclear accidents, floods, and incidences of employee-rage or violent behavior
- Communicating safety regulations and plans to employees
- Working with selected community groups to implement safety programs